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THIS CUMULATIVE REPORT DESCRIBES RESEARCH PREVIOUSLY PERFORMED ON TRANSFER AS A PSYCHOLOGICAL AND AS AN EDUCATIONAL PROCESS PLUS REPORTS OF NEW WORK. CHAPTER I OF THE REPORT DEALT WITH THE NATURE, HYPOTHESES, AND DEVELOPMENT OF THE PROJECT WHICH TAKES A SYSTEMS APPROACH TO THE ANALYSIS AND GUIDANCE OF THE LEARNING AND INSTRUCTIONAL CONDITIONS BY WHICH TRANSFER IS DETERMINED. CHAPTER 2 CONTAINED REPORTS OF SEVEN EXPERIMENTS ON TRANSFER EFFECTS OF DIFFERENT KINDS AND FORMS OF INFORMATION ENCODING. CHAPTER 3 REPORTED ON FIVE STUDIES CONCERNED WITH EFFECTS RELATED TO INSTRUCTIONAL VARIABLES AND TEST CONDITIONS IN LOGIC. TWO EXPERIMENTS ON THE USE OF A MODEL, ALONG WITH A GENERALIZED PREVIEW OF FACILITATING LEARNING AND RETENTION OF COMPLEX SCIENTIFIC MATERIALS, WERE PRESENTED IN CHAPTER 4. CHAPTER 5 REPORTED ON TWO EXPERIMENTS DEALING WITH TRANSFER EFFECTS IN VERBAL LEARNING. ATTACHED TO THE REPORT WAS A BIBLIOGRAPHY OF WORKS ABSTRACTED FOR THE PROJECT. (GD)

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Quarterly Reports No. 8 and 9

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TRAINING RESEARCH LABORATORY

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Preface

This progress report replaces those previously issued. The report plan is to cumulate the descriptions of work performed under this contract so that each new report contains the essential content of the earlier reports plus new work.

Experiments, or studies (sets of experiments), that are described in the following pages will be reprinted in greater detail in individual technical reports to be issued as the work is completed. When this is done, the summary contained in the progress report will be briefer and the technical report will be cited for reference. When a technical report is published, a complete citation will appear so that it can be secured. Copies of technical reports are placed in the University of Illinois Library and on deposit with University Microfilms, Ann Arbor, Michigan, so they can be obtained directly from these sources, requesting them by title.

In the present report, the first chapter presents a brief summary of the rationale developed in Phase I of the work program. Chapter I outlines the general plan of work for the project. Each of the remaining chapters deals with experiments that involve a single instructional vehicle, e.g., mathematical formulas, logic, science, and language.

In Chapter II, for example, the vehicles are mathematical formulas. A variety of problems relating to teaching and learning are being examined with the use of a formula as an instructional objective. Variations in the encoding of data to which the formula applies are being studied. For example,data are displayed in a field bounded by coordinates. There are two distinctive stimuli in each field. Each stimulus, by virtue of its position in the field, assumes one of four different values on each coordinate. The learner has to distinguish the relevant coordinate, assign values to the position of each stimulus and relate these values of the two stimuli in such a way that he can determine $\underline{k}$, the value of the unknown. The other form of encoding used to display data is a set of four geometric figures ("frames") each containing within it a value; however, only two of the frames are relevant. The learner must distinguish the two that are relevant and relate these in such a way that he can determine $\underline{k}$, the value of the unknown. The studies deal with variables presumed to affect learning and transfer (see p. 14 of Chapter I for six classes of variables used). These studies illustrate the general plan of the project which is to study a set of psychological questions relating to transfer using a specified type of task.

Some of the questions studied in the experiments described in Chapter II using mathematical formulas as problem solving tasks also are being studied with other tasks. For example, questions relating to the sequence used in presenting learning materials. In this connection, the asynchronous and synchronous character of sequences is being studied. All conceptions of teaching which specify a sequence in which materials are to be presented can be translated into an asynchrony measure. Consequently, this variable has rather broad potential application to education. It is neutral with respect to subject matter and provides an objective means for describing sequences of learning materials and for scaling them for quantitative study.

Chapter III contains a series of experiments in which the students study materials in an introductory course in logic, using a self-instructional program.

The formal structure for these materials therefore, differs from that used in Chapter II where a mathematical formula was to be learned. Within the context of logic, the formal relationships involved in syllogistic reasoning were selected as a useful and interesting experimental and educational problem. In this case the structural characteristics of the task are specified and should serve as critical cues for correct performance. Different formal characteristics of a task which meets the conditions described in Chapter I are being selectively studied in Chapter III in terms of the potential cue value of syllogistic forms. For example, the various forms of syllogism are specifiable and discriminable from one another and as a verbal structure each could acquire cue value in the acquisition of a learning set. Thus, a student could be said to acquire a learning set for syllogisms of form A or O, for example. The question is whether students do actually acquire such sets, or, in other words, whether the form of the syllogism acts as a cue. If this seems to be the case then the next question is whether variables like those identified in Chapter I are related to the amount or direction of transfer that is observed in applying what is learned. These studies get at a basic problem in the extension of the thinking of Harlow about learning sets which currently is based on laboratory tasks although alluded to by Gagné in the context of mathematics. It is necessary to determine, for substantive areas of interest to education, just what features of tasks actually define learning sets, if any do. The working hypothesis used here is that formal structural features of tasks can serve as cues for the formation of learning sets.

Various conditions relating to word meaning also are being studied in the work reported in Chapter III to determine their contribution to transfer. Thus the transfer implications of semantic and encoding variables are being examined.

In addition, various questions relating to programed instructional techniques are included in research designs, e.g., linear and branching techniques. Another set of relationships of interest are those relating the learner's abilities, aptitudes, and personality to methods of instruction. These individual differences variables are related to performance on tasks requiring the application of information previously taught. The data used are scores obtained on application items of achievement tests which presumably measure transfer. "Application items" are included in the tests given before and following training so as to provide a gain score. Another problem area included in this set of studies relates to the encoding used in communicating concepts to the students. This problem also is being examined in Chapter II using algebraic, geometric and matrix forms of encoding to determine their effect on learning and transfer. In the logic studies two notation systems are being used. There are the Peano-Russell and the Polish notations. These are supposed to be "equivalent" ways of handling concepts of symbolic logic. One purpose of these studies is to determine if these two notation systems are equivalent psychologically, and if not, in what ways they differ.

In Chapter IV transfer problems relating to the learning of a science are being studied using a self-instructional program. Organizational questions are being studied and the specific conditions used are those relating to some current theoretical notions about the way conceptual materials are most efficiently put together. These studies relate to those supported by the research being conducted under an Office of Naval Contract, Nonr 3985(04).

Some of the transfer implications of having students learn a fixed sequence of meaningful terms such as a vocabulary are being studied in Chapter V. Here is a basic set of conditions being used in a set of studies to identify some of the transfer implications that follow from associative conceptions of meaning. Other studies relating to language learning are planned. For example, a program teaching Latin roots and prefixes has been drafted to teach verbal decoding skills for English. It is to be used with some high school students and could be used with foreign students learning English as a second language. Transfer will be determined by the student's ability to decode new words.

One of the conditions studied in relation to two rather different types of learning tasks is the transfer effect of simply telling the student that the second task is related to the first one learned. In an experiment described in Chapter II some students are told that two differently encoded and therefore differently appearing tasks are actually related to one another. In Chapter V students under two conditions are told that the lists of words they are learning are related and the two different relationships are each described. In learning to use a mathematical formula (Chapter I), awareness of a relationship and the intention to relate the two tasks also are examined to see their effect on transfer. All of these studies relate to the effects of verbalizations on transfer. They attempt to render the notion of verbal awareness into an operational form for objective study in relation to transfer.

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Chapter I

Nature of Project

This project was developed to provide information about transfer as a psychological and as an educational process. The need for information about transfer is critical for the efficient planning of courses, curricula, and media for education. The current problem is not only the lack of available information, but also the failure of existent information to be linked to either the educational or the training decision processes to which it can and should contribute.

This project takes a systems approach to the analysis and guidance of the learning and instructional conditions by which transfer is determined. The guidance of learning under replicable conditions can be accomplished through the use of a variety of media, and each one can be an integral component of a computer-assisted instructional system. Also, the psychology of transfer is being studied here in fundamental and applied ways so as to explicate its facets through both conceptual analysis and experimental study. Programed instruction and a computer-based teaching system are being used to provide a replicable and realistic instructional environment. Once the principles of transfer are identified and understood, they can provide guidance for teaching as accomplished by any means. Transfer principles can contribute to both the pretutorial decision making and to the dynamic tutorial decision making which takes place while the student is learning.

Programed instruction and a computer-based teaching machine provide a medium for the investigation of the basic and applied problems of instruction, and satisfy the long-needed laboratory-like conditions *in situ*. This medium allows for the analytical and longitudinal study of transfer in ongoing instructional settings. In addition, the individual factors that combine to produce the complex effects that occur when transfer takes place in school learning situations can be controlled and examined separately.

Hypotheses About the Nature of Transfer and Variables Affecting it

A useful beginning for a research program would be to examine the data and concepts of transfer from a point of view which both (1) assumes that there is a fundamental relationship between the learning theorist's conception of learning and transfer processes, and the psychometric theorist's conception of aptitudes and abilities; and (2) assumes that there are at least three basic characteristics of complex tasks (their quality, texture, and structure) that determine the specific transfer effects which occur within and between tasks.

Granting the first of the above assumptions, the second can be examined for its implications. Very briefly, this point of view suggests that transfer may be viewed in two ways. The *first* view is cumulative transfer which takes place when the student is confronted with a homogeneous set of problems from which he can acquire "learning sets" (see Harlow, 1949; Gagne and Paradise, 1961). In other words, the student learns a class of actions that achieve a single function with respect to a set of stimuli, e.g., an object quality discrimination learning set, an oddity learning set, an "obtaining products with zero" learning set. Homogeneity, as used in this context, refers to a formal similarity among a set of learning tasks. The particular learning set that is acquired constitutes what is meant by the quality of the learning that has developed. Learning sets may be attitudinal (involving sets of cues and emotional responses), psychomotor (involving sets of cues and motor responses),or cognitive (see Bloom, 1956). The cognitive learning sets are both content related,in that they involve content cues and content related responses, and substantive in nature. Attitudinal learning sets are dispositional in that they involve approach or avoidance responses. Psychomotor learning sets are skills. The particular group of learning sets actually acquired by a learner constitute the texture of the learned behavior. The texture of behavior which the student learns may include one or more of the possible types of learning sets.

The second view is hierarchical transfer, i.e., transfer from learning set to learning set when the sets represent different levels. The structure of behavior refers to the hierarchical relationship found among a group of learning sets (e.g., Gagne and Paradise, 1961). Each hierarchy of learning sets has a pattern and distinctive form or architecture that is a result of the conditions of learning and the degree of overlearning. Qualitative learning sets, including content, attitudinal,and psychomotor learning sets may all be involved in a particular hierarchical structure. Each is presumably cued to the others in a pattern that represents a hierarchy. It is assumed that a hierarchy of learning sets is developed through a process of cueing, but the pattern of interrelationship that does develop for a learner may not agree with the formal analysis of the subject matter. Furthermore, the sets may not develop from lower to higher levels of learning sets.

In this analysis of the learning of complex behavior repertoires, it is assumed that the student confronted with a homogeneous set of problems from which he can extract a general concept (content learning set), an attitude, or a strategy (method of attack and possibility some psychomotor skills), will actually acquire individual learning sets to varying degrees of proficiency. Thus, the development of learning sets is a variable outcome of the learning experience. While the individual learning sets vary in the degree to which they are overlearned, those that meet minima constitute the qualitative elements of the resulting behavioral texture. A texture does not involve interrelated sets, however. Whether or not the learning sets also constitute a behavioral structure depends upon the extent to which the constituent sets are cued to one another. The typical object quality discrimination learning set, for example, is cued by perceptual characteristics of objects (e.g., color, form) to the psychomotor response set of reaching and lifting small, light-weight objects. However, it also could be cued to paintings of objects, photographs, or to written descriptions and it could include writing, object descriptions, or even attitudes.

In education and training, the task of the teacher is one of building complex, structured behavioral repertoires which typically involve classes of cue-response relationships. The problem, therefore, is to determine efficient ways of building higher order conceptualizations out of lower order ones by using different sequences of materials and different conditions of learning and responding. To do this, selected tasks of the kinds faced by students in school (e.g., high school mathematics, logic, English) can be analyzed in terms of the hierarchical structures revealed by a content analysis. Each analysis will provide the basis for an hypothesis about organizing the training given to selected groups of students in order to study the transfer effects it produces.

The behavioral analyses initially will make use of Bloom's _Taxonomy of Educational Objectives_ (1956); Guilford and Merrifield's work on the structure of intellect (1960); Gagne and Paradise's (1961) learning set procedure; Stolurow's (1964) task taxonomy, and related approaches to behavioral analysis. These provide useful materials for the eventual development of a generalized conception of transfer that will relate to basic problems. The _first_ set of basic problems consists in methods of instruction and training, particularly those pertaining to instruction over extended periods, as required in learning a school subject: (1) concepts for _sequencing_ learning set materials, e.g., class descriptive cues, asynchrony, and (2) principles for _handling_ specific aspects of training such as the encoding of cues and prompts, knowledge of results, and evaluations of student responses. The _second_ set of basic problems consists in the relevance and use of information about intellectual structures in making decisions about training. Here, the concern is with the identification of aptitudes and abilities for the purpose of using this knowledge about the learner to predict and optimize successful performance on new learning tasks, both initially and during the course of instruction. The _third_ set of basic problems consists in relating each educational objective to intellectual and instructional data so as to provide a consistent mechanism for interrelating these three sets of data in making instructional decisions.

Aptitudes, mediation processes, and transfer. In formulating the SOCRATES model of teaching, it was assumed that there is continuity in the processes measured by tests of individual differences and in the processes postulated by the learning theorist to account for the acquisition and transfer of knowledge and skills. In this respect, the SOCRATES model is consonant with the theoretical positions of Ferguson (1954, 1956), Osgood (1953), and Guilford (1950). The underlying hypothesis is that the skills and mechanisms developed while learning a variety of tasks that have a common structure, when overlearned, become the abilities and aptitudes that are measured by tests of individual differences. From sets of structurally related tasks the learner learns how to learn (e.g., Harlow, 1949), which means he can more readily acquire new cue-response relationships involving the same formal property. It is further assumed that a great deal of transfer of training is achieved simply because the same processing skills are involved. Consistent with Ferguson's position, it is assumed that overlearning brings these patterns of behavior to a level where they become relatively invariant, and at some minimal level of invariance these behavior patterns can become apparent through performance on tests of abilities and aptitudes. The contribution of these relatively invariant behavior patterns to the learning of new associations is their transfer effect.

It is assumed that all learning involves mechanisms that can be called processing skills. These skills aid the learner in acquiring associations in structurally similar situations as well as in those containing common perceptual elements. Overlearning of processing skills comes about by the learning of specific skills that fall into classes or sets of experiences which, while they may differ in detail, nevertheless involve common formal elements such as represented by the simple, and now classic, cases of transposition and oddity. The explanation of the development of learning sets, in spite of apparently varied experiences (cue-response learning), is that cue-response sets have some formal or relational elements in common. While this appears to be a reasonable hypothesis,as suggested by the research of Harlow (1949) on learning sets, the actual mechanism that provides the behavioral condition represented by the formal property held in common by(oddity problems for example) is not always easy to identify. In the discrimination learning set, for example, the learner simply responds to the individual features of the displays as cues and, if he is correct, he continues to use the cue; if he is wrong, he shifts to another cue. In other words, knowing you are wrong means that another feature is to be used.

The general working hypothesis relating transfer to abilities is that transfer effects are frequently accounted for in terms of processing skills which are common to the learning and transfer task. It also is assumed that the transfer effects are predictable in terms of specific ability and aptitude tests plus specific relevant knowledge or skills. In brief, it is assumed that the mechanisms which account for transfer are of two basic kinds which differ in terms of the characteristics of the learning experiences involved. They are (1) those that are content specific and typically studied in research relating to the common element theory of transfer (Thorndike and Woodworth, 1901), and (2) those that are process specific and,as a result, general with respect to content. The distinction between the two types of transfer lies in the type of cue that provides the linkage between tasks. The common element theory of Thorndike and Woodworth assumes that the perceptual elements are the links. The number of common letters in words is one example of the type of element that figures in this conception of transfer. In Harlow's learning set formulation of transfer, the linkage is not a cue for response but rather is a stimulus that is contingent upon response. The stimulus materials used in the Harlow discrimination learning set experimental paradigm do not have a common perceptual element running through the set of paired objects (e.g., red color, or round form), but rather, any pair of stimulus objects can be used in the set. In fact, a common element in the perceptual characteristics of the set would be undesirable, for what the learner acquires from the early discriminations, in addition to the specific discrimination, is that one and only one stimulus object in every pair is followed by a reinforcement stimulus. Consequently, when shown a new pair of objects, the learner selects one and,if he is reinforced, continues to select that member of the pair. However, if his response is not reinforced, he responds to the other stimulus object on the next trial. The cue to persist or to change is the presence or absence of the reinforcement stimulus following a selection response. Thus, only one trial is needed to solve any new discrimination. The common element is not in the discriminanda, but rather in the reinforcement stimulus that follows the response. The fact that the critical cue is response dependent, rather than an aspect of the discriminanda, makes the transfer more general since it is associated with the more generic and abstract characteristics of learning experiences such as their structural and semantic aspects, their problem solving characteristics, their amenability to analogy, their isomorphism with a particular model, or their logical or mathematical properties. These aspects of a set of stimuli, as contrasted with a specific set, may be coded in the context as well as in the events following response. Any sign that is correlated with a structural feature of complex materials can acquire a cue function in the same way that a physical property of an object does. Therefore, it can elicit a response that is cue producing, and the cue that is produced can account for any transfer from otherwise dissimilar appearing tasks. The structural characteristics of tasks like forms in music, poetry, or prose (e.g., a chord, a sonata, a sonnet, a simple declarative sentence, a dialogue), can become cues for responses as evidenced by the sheer fact that they can be discriminated. The structure of a task as a cue is potentially useful as a basis for transfer,for it can serve as the common element between and among a set of otherwise dissimilar tasks in the same way as can a physical, or perceptual characteristic that is common to a set of tasks. The structures of grammar, of mathematical proofs, and of a syllogism, for example, illustrate the potential cue value for transfer of stimuli patterns with subject matter relevance. The actual significance for transfer of these formal properties of tasks, which are otherwise very different from each other, is unknown. This is a neglected property of tasks with respect to transfer, but one that has the potentiality of functioning in transfer of training as the basis for the development of important learning sets. Its relative potency depends upon the relation salience of these features of learning tasks as compared with the perceptual features. Furthermore, structural consistency requires a set of stimuli as the vehicle since it is to be recognized as a property of two or more exemplars.

These structural characteristics of learning and transfer tasks can be studied (to the extent that they can be identified) as the common element, or unifying mechanism, that might account for transfer from otherwise apparently diverse learning experiences. For example, Crutchfield and Covington's (1963) successful use of programed learning experiences involving mystery stories, as a means of improving the problem solving performance of students on Dunker types of tasks (which have no common content with the learning experiences), illustrates the potential transfer value of skills cued by formal or structural characteristics of the learning experiences. The labeling of something as a problem elicits the repertoire of problem solving responses that the learner has acquired. These may be simple and insufficient or complex and sufficient, but whatever their state of development and complexity, they produce cues that lead to behaviors not previously associated with the stimuli presented,and frequently produce solutions,as in the case of the algorithms of mathematics. While the verbal statement of the problem and the numerals may be new to the learner, the fact that he is confronted with something that is labeled as a mathematical problem is a sufficient cue to produce a complex set of responses that involve information on data processing. Included among the responses are searching for and discriminating between quantities, terms for units, and for relational words (e.g., ratio, equals, greater than). These responses, then, provide the cues for writing of formulas or equations. The written expressions produce stimuli that then serve as cues for transformation or for calculation, etc. These behaviors lead to the solution of the problem when they are the appropriate set.

A number of experimenters, such as Royce (1898); Slosson and Downey (1922); Osborn (1957); Maier (1931, 1933); Judson, Cofer and Gelfand (1956); and Maltzman, Brooks, Bogartz, and Summers (1958), have investigated various training procedures in attempts to increase the frequency of original behavior. Thus, originality (often considered an aspect of creativity), as a form of performance on a variety of tasks, has been considered a transfer phenomenon as well as a human ability (Guilford, 1950). It is the relationship between aptitudes and transfer skills that needs to be made explicit in order to account for the transfer of originality.

Research Program

The general hypothesis is that the language used, or the particular set of symbols (including pictures) employed, in teaching a concept is a variable which affects the nature of the behavior that results and produces cues for other responses and, thereby, determines the transfer effect of the learning experience.

Encoding Factors

One study relating to this general transfer hypothesis will use a self-instructional program in logic which extends the work begun with the multiple correlational task used by McHale, Stolurow, Mattson and Davis (see Chapter II). The studies using the logic materials (Chapter III) will compare the transfer effects of two versions of a program: one written in the Peano-Russel notation, the other written in the Polish notation. Each of these notation systems has a structural similarity with a different language system. The hypothesis is that this structural similarity will result in different rates of learning and amounts of transfer for students who have different educational backgrounds and aptitudes. Students who have studied a large amount of mathematics and comparable students who have had very little mathematics will serve as subjects ; mathematical and verbal aptitude scores will be secured for both. Half of the students will study each version of the logic program and half of those who study one version (e.g., the one written with the Polish notation) will be transferred to problems expressed in the other notation system. The same will be done for the other half of the student group. In other words, there will be two transfer tasks. One transfer task will require the students to use the other form of symbolic encoding rather than the one they studied. The second transfer task will require students to solve problems in the notation they were taught, but the problems will be different from those they were taught, but will be capable of being solved with the concepts and techniques taught. The latter transfer task will require the application of what was taught to new problems.

Of primary interest in this study is the extent to which the form of encoding effects the student's responses which, in turn, cue the repertoire he has of relevant behaviors. The differences in correlation between verbal and mathematical aptitudes and scores on the two transfer tasks following each condition of learning will reveal the extent to which instructional decisions can be made more efficient for a particular student by selecting the form of encoding on the basis of aptitude. If the Peano-Russel notation, for example, is more readily learned and applied by students who have higher mathematical than verbal aptitude, but the Polish form of encoding is more efficiently learned and used by students who have higher verbal than mathematical aptitude, then this finding would provide support for the hypothesis that the form of encoding is important in making the structural features of tasks more salient as cues. It also would provide a basis for making pre-tutorial instructional decisions involving the form of program to use.

Concept Sequence in Relation to Aptitude

Another study using the logic materials concerns the sequence in which concepts and skills are taught. For example, in one sequence, syllogistic reasoning will be taught before symbolic logic. In the other sequence, symbolic logic will be taught first and then syllogistic reasoning. The latter sequence is suggested by the generality of the concepts, but the instructional strategy to be studied is teaching the more general concepts first. The former sequence is the historical order in which the concepts were developed and teaching the specific before the general; the alternative strategy, with which it will be compared, is going from the general to the specific. These instructional strategems have been implicit in many teaching programs, but explicit in only a few; however, the purpose here is to secure relative effectiveness for transfer of training.

Encoding and sequence problems arise in a variety of contexts and have obvious educational media implications. Every medium requires that some form of encoding be used to represent the concepts to be taught, and that the material be organized into a particular sequence. Both studies provide data on these factors in transfer within a subject matter, as well as data concerning the value of aptitude data for forecasting learning and transfer scores under different learning and transfer conditions.

Relating to the studies using the logic materials will be those using materials to teach English vocabulary or word attack by the analysis of the roots and prefixes of words. In these studies, the design will be a simple one-way analysis of variance with levels of knowledge as the independent variable. The program teaches vocabulary by analyzing words into Latin roots and prefixes. It will be used with students who have had different amounts of Latin and one group who has had no Latin at all. Scores on Latin tests also will be used in correlations if they are reliable. After completing the program, transfer will be determined by giving the students words which were not included in the instructional material, but for which the meaning could be determined if the analytical processes taught by the program were used to examine prefixes and roots. If Latin training provides transfer, then the means of the groups differing in amount of formal training in Latin should show a correlation with the amount of Latin studied. If the general skills of word analysis are useful, then the students who have not studied Latin should transfer as well as those who have studied Latin. In addition to group differences, correlations will be obtained between aptitude (verbal and quantitative), amount of Latin studied, and scores on the learning and transfer tasks.

Tutorial Conditions in Transfer

Transfer is dependent upon the quality of learning. The quality of learning is established by several factors, such as (1) the performance standards met by the student in learning; (2) the criterion used in giving knowledge of results; (3) the basis for providing evaluative feedback; (4) the overlearning criterion used; (5) the procedures used in withdrawing stimulus supports (fading, vanishing, prompt or guidance removal), and (6) the encoding of the concepts and information studied.

Overlearning. Although it is well established that there is a positive relationship between the amount of practice on the first task and the amount of positive transfer that results in learning the second task (McGeoch and Irion, 1952), there are no data to indicate the optimum amount of practice or overlearning to give the student on the learning task before he is given the transfer task. Furthermore, there are no norms to indicate the amount of overlearning that is optimum for different aptitude levels. This problem will be studied and, the experimental designs will be those of proactive interference and retroactive interference.

Sequence and length. One study, with the proactive design, might use a set of concepts to be taught to each group in one of two different sequences. In this case, the effects of the difference in sequence would be looked at in terms of transfer which would be measured by the student's rate of learning a new set of concepts. The transfer task would be the same for both groups. One learning sequence would present similar concepts grouped together (e.g., class descriptive cues would be used to group materials, see Stolurow, 1956; Wulff and Stolurow, 1957), while the other sequence would present the same concepts arranged so that the set of concepts learned at any one time would be maximally dissimilar (the principle of asynchrony will be used in Chapter II). An additional variable in this design would be the length of the task, varied by using a different number of concepts taught at one time. This variable could be assigned five values as the length of lessons, e.g., 4, 8, 16, 32 and 64.

Other studies also will be designed to reveal the applicability of basic laboratory research on proactive interference for education and will provide an opportunity to study the relationship between proactive interference and retention (which Underwood, 1957, considers more critical than retroactive interference as a factor determining retention). In these studies, a fifth-grade arithmetic program in fractions which teaches fourteen concepts, and a statistics program which teaches concepts and computational skills for the mean, median, variance, standard deviation, correlation, etc., could be used.

Research will be designed to compare groups to whom a set of concepts will be taught in alternative sequences, permitting analyses to determine the effects of proactive and retroactive interference. In addition, experiments will be designed to determine whether learning-how-to-learn effects (cumulative positive transfer) or proactive interference (cumulative negative transfer) occur within the context of subject matters such as logic, statistics, or mathematics.

A Cybernetic Model for Research on Learning and Transfer[1]

A model of the instructional process has been developed in order to systematically interrelate the decision processes involved in instruction. The model relates both the theory and the data pertaining to individual differences to problems of learning and transfer. A systems approach is employed so that the efficient utilization of media also is considered. The model identifies two sets of decision processes and relates them to one another; consequently, it provides a conceptual mechanism for the study of transfer of training over a broader range of problems than heretofore considered. This comprehensive view of transfer makes it possible to study transfer both from task to task and within a task, and to articulate the principles of decision making while students were learning.

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[1] The model translated into the design of a system is described in Stolurow and Davis (1964).

Two-stage instructional model. Figure 1 describes the pre-tutorial decision net; Figure 2,the tutorial decision net in minimal terms; and Figure 3,the tutorial decision net in greater detail. Consistent with a systems approach, critical functions and their relationships are indicated; however, the way in which the system components are designed and the way the entire system is used in teaching depend both upon the computer program (that provides teacher and professor functions, see Figure 3) and the set of objectives to be obtained. Essentially, the system guides the student's learning experiences and,while doing this, learns about each student and modifies the teaching accordingly (see Figures 1, 2 and 3).

Cognitive Transfer as Related to Transfer in Other Domains

This project provides the means for conducting basic systematic studies on transfer which relate primarily to the cognitive domain (Bloom, 1956). While the relevance of the data to other domains such as the affective and psychomotor are not to be ignored, they are not the primary focus. It is believed, however, that the method and the findings will be highly relevant to these other domains and specific indications of such relevance is to be sought and pointed out wherever possible.

Transfer is critical to curriculum development. The new curriculum programs for schools, colleges, and professional training institutions involve many assumptions about the methods of accomplishing transfer which need to be tested. Furthermore, information about the cumulative transfer process, for which little or no data are available, needs to be systematically accumulated. Thus, a focus upon transfer in the cognitive domain seems to be indicated.

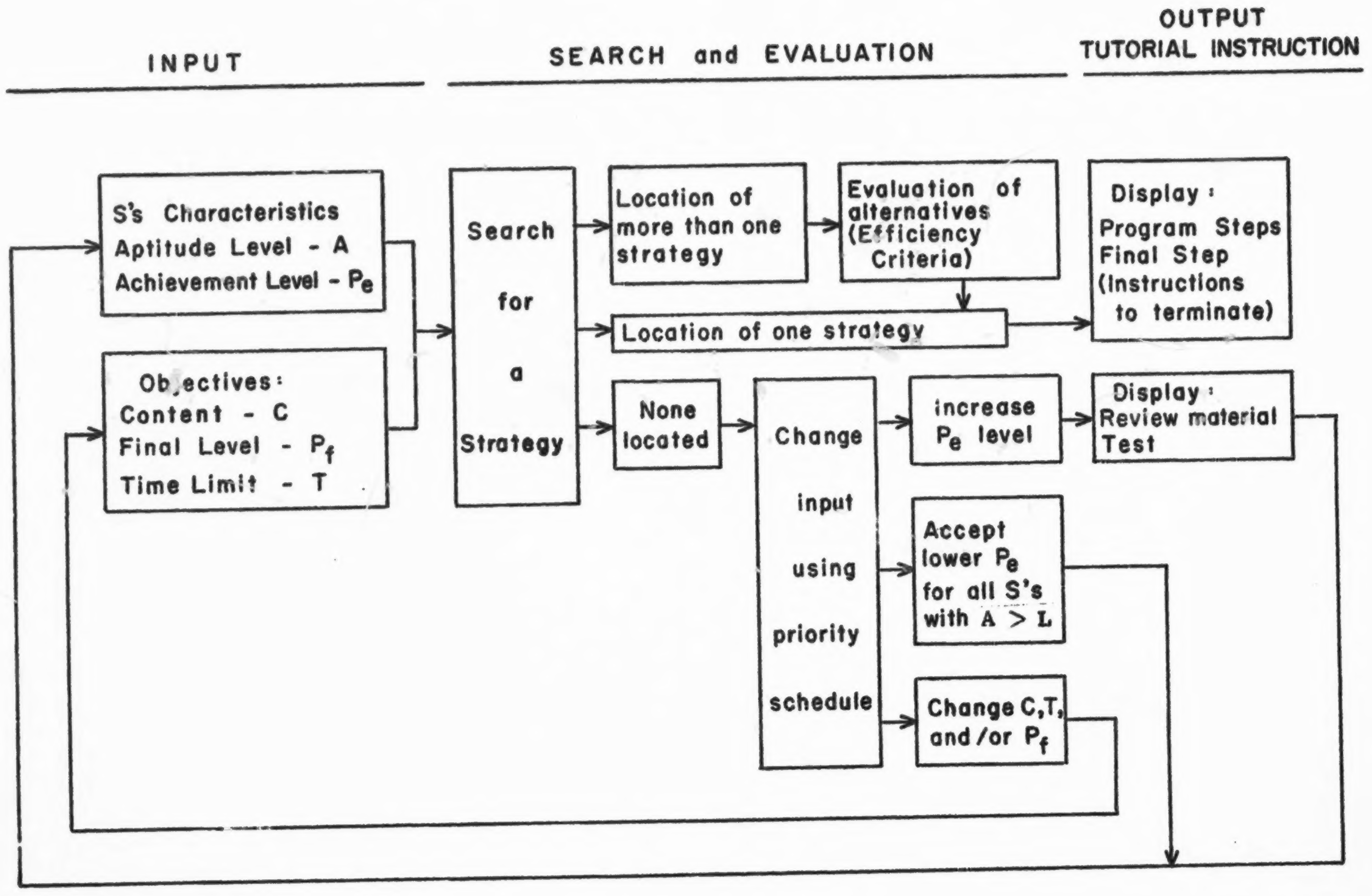
INPUT
SEARCH and EVALUATION
OUTPUT
TUTORIAL INSTRUCTION
S's Characteristics
Aptitude Level - A
Achievement Level - P_e
Objectives:
Content - C
Final Level - P_f
Time Limit - T
Search for a Strategy
Location of more than one strategy
Evaluation of alternatives (Efficiency Criteria)
Location of one strategy
None located
Change input using priority schedule
increase P_e level
Accept lower P_e for all S's with A > L
Change C,T, and/or P_f
Display: Program Steps Final Step (Instructions to terminate)
Display: Review material Test

Figure 1. Pretutorial Decision

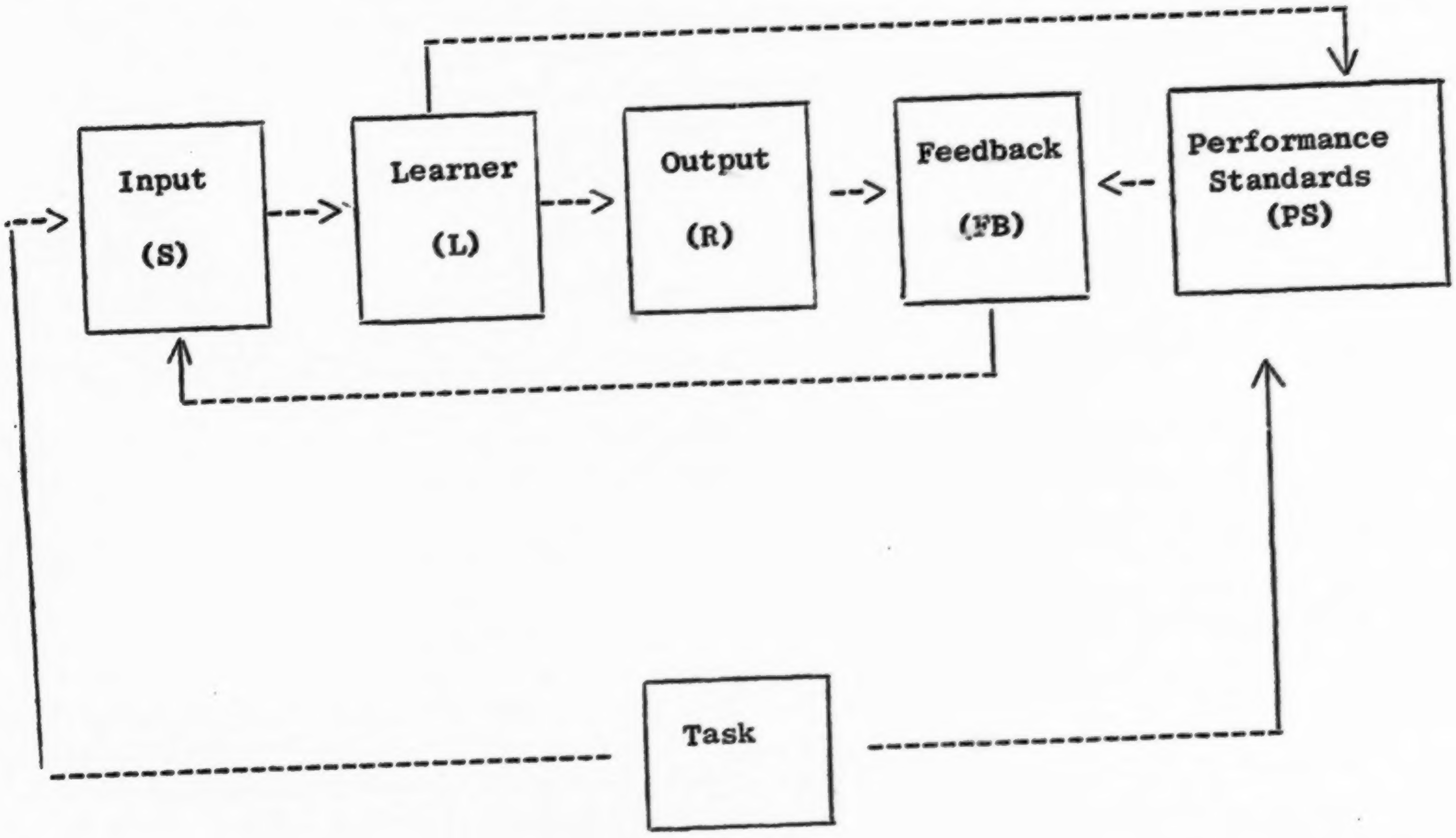
Input
(S)
Learner
(L)
Output
(R)
Feedback
(FB)
Performance
Standards
(PS)
Task

Figure 2. The Tutorial Decision Process: Basic Cycle and Specification of Task Parameters.

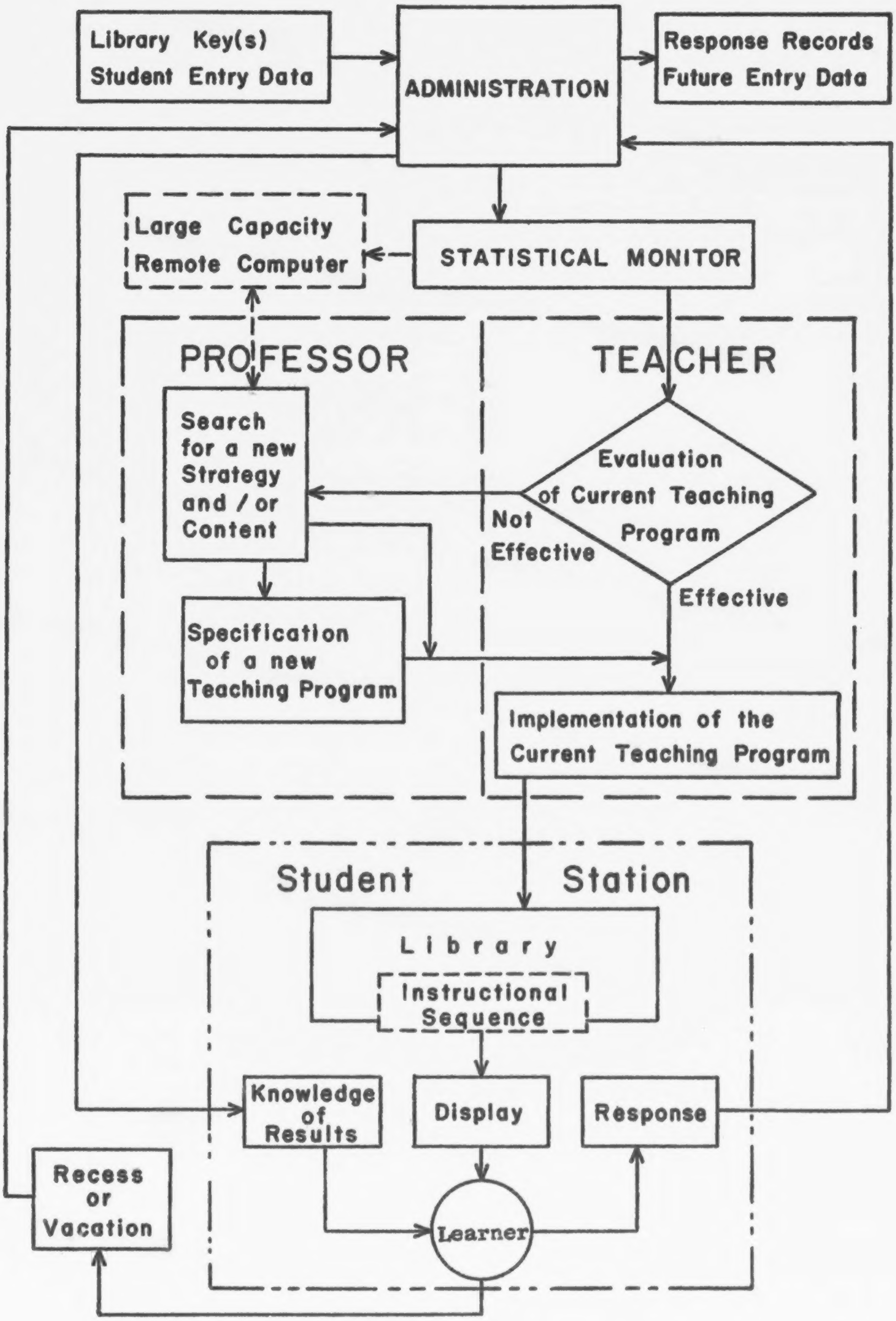
Library Key(s)
Student Entry Data
ADMINISTRATION
Response Records
Future Entry Data
Large Capacity
Remote Computer
STATISTICAL MONITOR
PROFESSOR
TEACHER
Search for a new Strategy and / or Content
Evaluation of Current Teaching Program
Not Effective
Effective
Specification of a new Teaching Program
Implementation of the Current Teaching Program
Student Station
Library
Instructional Sequence
Knowledge of Results
Display
Response
Learner
Recess or Vacation

Figure 3. Flow Diagram of SOCRATES System.

Two very basic problems arise in the study of cumulative transfer. They involve the programing of a subject matter not only to teach existent facts and concepts, but also to develop particular cognitive styles or strategies through the formation of associative structures. These twin problems are not only present in all of the curriculum development projects, but they are basic to every educational program. In spite of over 60 years of research on transfer (Thorndike and Woodworth's study was in 1901), there is almost no definitive information or explicit guidance to offer the curriculum builder. Thus, these issues are in critical need of substantial study from a fundamental point of view.

Purpose

Objectives

Phase I has the following objectives: (1) to develop an organized evaluation of available experimental and theoretical studies of transfer under the following rubrics -- summary and analysis of research; review and consolidation of theory; relationships between learning and transfer; relationships between transfer, abilities, and aptitudes; and relationships between transfer and problem solving; (2) to formulate principles of transfer as they relate to particular educational media, methods, and practices; (3) to conduct preliminary transfer studies appropriate and necessary to determine the feasibility of particular research applications of the new media; and (4) to formulate plans for a second phase of research on the relationship of transfer of training to educational processes and media.

Phase II has the following objectives: (1) to initiate a plan of research on transfer of training in relation to educational processes and media; and

(2) to prepare manuscripts for publication from the materials developed for objectives 1, 2, and 3 of Phase I.

Method

Procedure

General. The research program will be developed and guided by the data and findings obtained during each phase of work. The initial phase has generated both results and plans. Subsequent phases will obtain most of their data from empirical studies rather than from literature surveys. Later phases will differ in length and level of activity, depending upon their potential importance to education and the state of the art with respect to technological and theoretical development. Therefore, it may be necessary to defer work on a more important substantive problem until the answers to some less important technological problems or techniques have been developed.

Phase I. The first phase consisted of a survey of the existent data and concepts for two purposes: (1) to summarize and integrate research and theory and to consolidate and interpret research findings which will result in articles and monographs of an integrative and critical nature; and (2) to consider these findings in relation to the problems of education so as to produce a set of hypotheses for research and a workable plan with which to conduct studies that relate to one another in a way that contributes to particular educational problems.

The procedure for Phase I was largely library research plus the analysis and synthesis of existing information and concepts. Reports, articles, monographs, and books were abstracted (see Chapter VI) and interpretive summaries are being prepared. In addition, preliminary empirical research was conducted using such instructional materials as logic (Chapter III), multiple correlation (Chapter II), and an artificial science (Chapter IV). These studies have dealt with the following basic problems in transfer: (1) sequencing, e.g., inductive (discovery) vs. deductive (Ruleg, see Evans, Homme and Glaser, 1962), Detambel and Stolurow's asynchrony (1956), Ausubel's subsumption theory (1963); (2) learning-how-to-learn e.g., Harlow, (1949); and (3) mediation theory e.g., Osgood (1953).

Phase II. The procedure in the second phase will be associated less with library research than it was in Phase I. There will be a marked increase in the amount of empirical research designed both to elucidate transfer problems and to develop techniques and media.

Use of programed instruction. Experiences with programed instruction have indicated that it is not only a feasible method of teaching, but also a valuable research tool ideally suited to the study of transfer. Media such as television, film, and magnetic tape also are useful and, although they are more limited, they will be used, as appropriate, to provide experimental control and objective manipulation of variables. These media will also be used to provide a permanent record of the learning and transfer conditions used and, in this way, will objectively define the procedures and conditions in a way that is difficult to accomplish when live teachers are used to study these processes. With programed instruction and film, effective techniques can be represented for teacher training purposes. These materials could be important by-products of the basic research project if developed into teacher training materials.

Computer-assisted instructional research. To a considerable extent, the research program will consist of studies that involve the on-line use of the newest and most promising of the educational media -- the high-speed computer. The Training Research Laboratory's computer-based system, SOCRATES (System for Organizing Content to Review And Teach Educational Subjects), is a unique system designed to conduct educational research, particularly on the learning process.[2] It is especially suited to the study of transfer in complex learning situations, particularly those lasting for a semester or a year. It can (1) store information about each student's aptitude, beginning knowledge, and personality; (2) use this information in making pretutorial decisions; and (3) use this information in combination with the detailed information it collects about individual students (their individual responses and study time) in making instructional strategy decisions. This capability previously has not been available in the study of transfer. Furthermore, it now exists in a form that provides data which can be processed immediately; consequently, decisions about each step in an instructional sequence can be made without delaying the sequence,and the computer can perform the statistical analyses of the data produced by the experiment.

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[2] While SOCRATES is currently being used for research, it is not limited to that since the components are commercially available and the basic computer (IBM 1620) is one that is widely used in schools today for other purposes. It would have to be coupled with an IBM 1710 and student interface units, however, to handle the remote input/output requirements of an instructional system (see Figure 4). SOCRATES was developed under ONR Contract Nonr 3985(04) which is currently providing support for its further development and for research on its use.

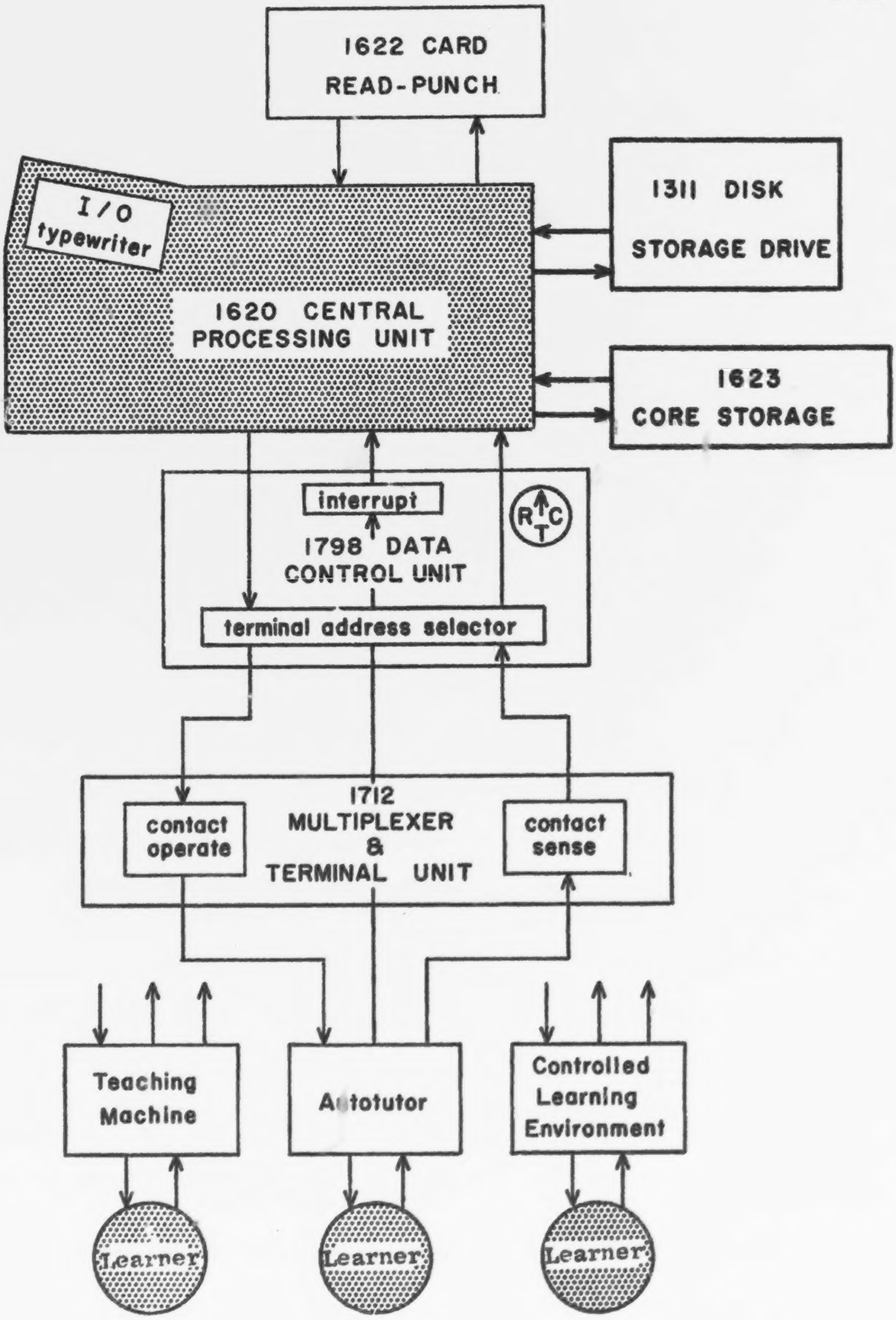
1622 CARD
READ-PUNCH
I/O
typewriter
1620 CENTRAL
PROCESSING UNIT
1311 DISK
STORAGE DRIVE
1623
CORE STORAGE
interrupt
R C T
1798 DATA
CONTROL UNIT
terminal address selector
1712
MULTIPLEXER
&
TERMINAL UNIT
contact
operate
contact
sense
Teaching
Machine
Autotutor
Controlled
Learning
Environment
Learner
Learner
Learner

Figure 4. The SOCRATES System: Equipment Interconnections.

SOCRATES was designed as a flexible system with respect to the media which could be used in the interface units. This provides flexible input and output requirements for the link between the student and the computer. For educational purposes relating to instructional media, the two basic problems pertaining to research on learning and transfer are (1) the design of the student interface units (the hardware problem); and (2) the design of the computer instructions that determine what decisions are to be made and when they are to be put into effect (the software problem). An important bi-product of the research proposed here is that it will contribute to both the hardware and software problems that need to be solved for the effective utilization of the computer as a medium of instruction and instructional research.

In the SOCRATES I configuration, the computer controls fourteen 35mm film transport mechanisms that have (1) rear screen projection, (2) selection response units that accept 10 different responses at every student station, and (3) forward and backward film motion under computer control. In the SOCRATES II configuration, the computer controls student interface units that have (1) rear screen projection, (2) separate message readout for knowledge of results, (3) completely random access to any one of fifteen hundred 35mm displays, (4) up to 15 response buttons, and (e) internal timing that permits control over a projection light that is independent of film transport timing. SOCRATES is an educational media laboratory in a real sense in that it is a flexible system which not only accommodates a variety of specific media (e.g., 35mm film, CRT displays, tape audio system), but also interrelates media to form a system for instruction in which each element serves a selected function. Furthermore, it provides a capability both for carrying out a complete set of instructional decisions and for processing the large amounts of data that are accumulated during the extended learning and transfer experiences of groups of individually taught students.

By using SOCRATES, it is possible to conduct studies of the transfer effects of pretutorial decisions about teaching methods based upon aptitude, ability, and personality information. Individual differences information will be used in making decisions about the treatment to be used to teach a defined set of concepts and a body of information. One type of treatment will be designed to compensate for the student's deficiencies so as to increase his ability, whereas an alternative treatment will be designed to capitalize on the student's existing strengths. These treatments will be examined in relation to age since different alternatives may be desirable for different age groups, e.g., compensate early and capitalize later.

Another series of transfer studies will be concerned with treatments that relate to tutorial decisions. SOCRATES will be programed to use different decisions with comparable students, depending upon the data it obtains from the students while they learn. Thus, the computer will learn about students while it teaches them; the rules of this dynamic decision making will define the treatments used. One series of studies on dynamic decision making to develop behavioral structures for transfer will deal with the alternative decision rules for organization of steps. Another series will deal with variations in feedback (e.g., response evaluation and delays in knowledge of results) in which the concern will be the stability and strength of the behavioral structure as revealed by retention and transfer scores.

Another series of studies will be concerned with cultural differences in the effectiveness of specific treatments. For example, in one culture, programed materials organized in terms of a ruleg conception could result in more transfer than the same steps organized in terms of a discovery conception; in another culture, the reverse could be true. Other studies will deal with variations in the discovery treatment, i.e., cue discovery, principle discovery, and response discovery.

Another series of studies will deal with treatment comparisons based upon cognitive grouping of frames vs. various alternatives such as spiral sequencing, class-descriptive cue clusters, random grouping, and student-determined clusters.

Consideration will be given to the feasibility of cross-cultural and interlingual studies in order to determine the generality of the principles of transfer.

Sample plan for subjects. Subjects will be drawn from different age and ability levels and,if feasible, from different cultural settings. The specific sampling procedures will be determined by the requirements imposed by the problem under study. Since aptitudes and abilities are an important set of data in the SOCRATES decision model, these data will be obtained uniformly and, in some studies, will be the basis for stratifying the sample of students used. Cultural differences also will be used in other studies and if possible, sampling conditions will be duplicated (where replication of earlier studies is being accomplished) to check critical findings. Where long-term transfer is being studied and students participate over an extended time period, statistical adjustment may be required to compensate for losses in the sample.

Treatments. As indicated, the initial studies will use programed materials in logic, mathematics, statistics, and language. These areas have been selected because they represent formal systems developed to solve complex problems. The proposed transfer studies will investigate cognitive, dispositional, and strategy skills. Since these are information processing skills, they can be thought of as contributions to the student's cognitive style, and they can be used in combination with a wide variety of different subject matters. The texture of these structures will be studied to determine ways of cueing them to content learning sets.

Controls. The programed instructional procedure of employing a computer-based teaching machine system (SOCRATES) will be used as the primary means of controlling the treatments for stability of presentation. In addition, printed programed materials will be employed whenever participating student groups are in locations remote from the laboratory. Both the filmed frames and the printed frames meet the necessary requirements for replicability of conditions.

Students will be assigned to treatments randomly in order to achieve both representativeness and comparability among groups. Where appropriate, aptitude, personality, knowledge, socio-economic, and cultural factors are to be used to control individual differences.

Data Types to be Gathered and Methods to be Used

Performance prior to, during, and following learning will be measured by instruments appropriate for the particular study. Evaluations made prior to exposure to selected learning conditions (instructional strategies) will be used to predict the direction and amount of transfer of training. Standardized tests of ability, aptitude, and personality will be used in addition to specially designed tests that determine the level of each student's entry behavior. Evaluations will be made of the nature and extent of learning, retention, and transfer. Following learning, broadly based standardized tests and specific tests of terminal behaviors will be used.

The computer will use the students' latencies and errors (as related to particular segments of a self-instructional program) in making decisions about subsequent learning experiences and these data can be related to the students' aptitudes and personality test scores as a data pool to be used in making dynamic decisions. Alternative models will be studied to determine their relative worth as bases for decisions about instructional strategies where positive transfer is the desired outcome.

The computer-based system will permit simultaneous monitoring of data concerning student ability, aptitude, and personality on the input side and relate it to response speed, accuracy, and attitudes on the output side. Furthermore, the developing relationships between input and output can be used either collectively or selectively to make different types of decisions regarding the very next step of a program. The decisions can relate to instructional procedures such as review, skipping, evaluation of performance, degree of student control of subsequent learning experience, pacing, difficulty level of materials, etc.

Several different performance outcomes will be considered: (1) learning new and related material; (2) problem solving in which the knowledge taught is directly relevant and sufficient; (3) problem solving where the knowledge taught is not necessary,but the strategy required is relevant and useful; and (4) inferring and extending the knowledge taught to new materials.

Transfer effects are evidenced not only in the development of hierarchical structures of content learning sets, but also in the degree to which these are interlaced with dispositional and attitudinal learning sets. Measures of these interrelationships will be accomplished in the manner described by Gagne and Paradise (1961).

Methods of Statistical Analyses

Analyses of variance, correlational techniques, and estimation procedures will be used. Analyses of variance will be used when hypotheses are tested. Correlational analyses will be used to determine relationships between input-output variables such as (1) ability test scores and learning task performance measures, (2) aptitude and retention, and (3) verbalization measures of understanding and transfer. Where appropriate and necessary, covariance and partial correlation will be used to assist both in making decisions and in the interpretation of findings. Residual scores will be used to measure gain (see DuBois, 1962) as a dependent variable.

Approximate Time Schedule

Phase I required two calendar years, ending June 30, 1964. The literature review which began at the initiation of Phase I will continue beyond Phase I, but at a reduced level. The incorporation of the computer-based teaching machine system into the research plan has suggested the relevance of new areas of information. Bibliographies and abstracts of studies are being compiled and several summaries are being written in anticipation of their completion by the fall of 1965. The bibliographies and abstracts will be coded for storage and retrieval within the computer; the coding systems to be developed for this purpose should be in operation by July, 1966. This coding and computerization will make the literature relating to transfer available to research workers in a form that is responsive to individual study needs. Literature relating to the new media also will be coded and abstracts for computer storage and retrieval will be prepared.

Specific research studies relating to Phase I are continuing to be designed and conducted, and new studies are being designed according to plans for Phase II. Thus, this continuing activity will increase in tempo throughout the next two years of Phase II. Reports relating to these studies will be prepared as the data are analyzed.

Phase II is projected as an eight-year effort consisting of four two-year periods. The first of these periods terminates on March 1, 1966 when the plan for continuation will be submitted as a second extension of the existing arrangement.

Publication Plans

The results of the studies will be reported individually and combined for related sets of studies, and will be reported in monograph or book form, as appropriate. It is contemplated that the articles will be published in standard psychological and educational journals, and that the books will be published by university and commercial publishers.

Principal Investigator

The Principal Investigator is Lawrence M. Stolurow, Professor of Psychology and Education. Dr. Stolurow received a B. A. from the University of Minnesota, 1940; an M. A. in psychology from Cornell University, 1946; and a Ph. D. in experimental psychology from the University of Pittsburgh, 1947. In addition to teaching experience at the undergraduate and graduate levels, Dr. Stolurow is head of the University of Illinois' Training Research Laboratory, which is administratively a part of the Department of Psychology and the Bureau of Educational Research.

List of Personnel

April 1, 1964 - September 30, 1964

Lawrence M. Stolurow - Principal Investigator

Research Assistants	% Time	Period of Employment
Richard Blomme	50%	1 April - 31 July
Lawrence Frase	67%	15 June - 30 Sept.
Robert Hart	50%	15 June - 15 August
John Kearns	50%	1 April - 31 July
Eiichi Koike	50%	15 Sept. - 30 Sept.
Henry Lippert	50%	1 April - 30 Sept.
Thomas McHale	50%	1 April - 15 June
Julie McHale	25%	1 April - 15 June
Ellen Rosen	50%	1 April - 15 June
Leon Swartzendruber	50%	15 Sept. - 30 Sept.

Clerical		
Bonnie Anderson	50%	1 April - 30 Sept.
Valerie Anderson	100%	15 June - 30 Sept.
Freda Blecher	50%	1 April - 30 June
	75%	1 July - 30 Sept.
Gerry Eisenberg	50%	1 June - 30 Sept.
Amy Henschen	50%	1 April - 30 June
	75%	1 July - 30 Sept.

Hourly	
Valerie Anderson	1 April - 15 June
John R. Dugan	1 April - 15 June
Paul E. Kirshke	30 June - 30 Sept.
Richard McNabb	1 April - 30 June
Mark Rifkin	15 Sept. - 30 Sept.
Gerald J. Suk	1 April - 15 June

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Chapter II

Study of the Transfer Effects of Different Kinds and Forms of Information Encoding

L. M. Stolurow, T. J. McHale, D. Mattson and D. J. Davis

A series of experiments was conducted to investigate the effects of two basic types of transfer of training in complex concept-formation tasks. Two different tasks were used which differed only in minor respects since each was generated from the same multiple-correlational model (See Azuma, 1960; Cronbach and Azuma, 1961a, 1961b). The two basic types of transfer of training were: (1) transfer to task performance from written instructions which differed in the amount of information they gave the learner, and (2) transfer from one task to the other where the relationships between tasks were specified. The latter includes both two-stage and cumulative transfer (learning-how-to-learn) experiments. The study is designed to investigate several basic problems such as (1) the informational value of different task characteristics, (2) the effects of different ways of encoding task-relevant information, and (3) the development and role of verbal mediating mechanisms (hypotheses) of the learner both when learning and when transferring to new tasks.

Experiment I

Amount of Information Conveyed by a Knowledge of Either the Principle or the Cues Given in Algebraic Form

Status: Report in preparation.

Purpose

This experiment was designed to investigate (a) the amounts of information communicated by the knowledge of a principle as opposed to the knowledge of cues, and (b) the effectiveness of the knowledge of a principle as opposed to the knowledge of cues at different stages of learning.

Hypotheses

1. A knowledge of the principle would be more beneficial than a knowledge of the cues since it is easier to learn the cues than their proper weighting and formal relationship (principle).

2. A knowledge of the cues would be more beneficial in the early stages of learning when the S must detect what is relevant, and a knowledge of the principle would be more beneficial in the later stages of learning when the S must determine the appropriate weights and relationships for the relevant cues.

3. The rank order of performance for the four groups will be full information, principle information, cue information, and no information.

Method and Materials

Subjects

Fifty-two undergraduates in psychology at the University of Illinois participated in the experiment with 13 Ss in each of four groups. Thirtyeight *Ss* were administered the task during a regular class period; the other 14 *Ss* were obtained from a subject pool and were administered the task in small groups. Of the latter, four were in the cue group, four in the full information group, and six in the principle group.

A 2 x 2 analysis of variance was used for x', x" and *k*, to detect the significant effects of principle, cues, or their interactions for each of the four trial blocks. In addition, Duncan's Multiple Range Test (1955) was used to test for significant differences between means of the groups in each of the four blocks.

Procedure

Task stimuli. Each stimulus presentation consisted of a 2.5 inch by 2.5 inch square with a small red cross and a small green cross drawn inside it. The left side of the square and the bottom of the square represented coordinate axes. The location of each cross was specified by its distance from the left side and the bottom of the square; these distances were its coordinate values.

Each of the four coordinates (x', y', x", and y") could take on one of four values -- 3, 6, 9, or 12. These four values correspond to actual distances of .5, 1.0, 1.5 and 2.0 inches. The number of possible combinations of the coordinate values was 4^4, or 256; however, since the crosses were not allowed to occupy the same location in any stimulus presentation, only 240 (16 x 15) combinations were actually possible and not all of the possible stimuli were used.

Presentation of stimuli. Stimuli were presented in a booklet of 128 stimuli, or trials, with six different stimuli on each page. On the answer sheet, there were 10 numbers for each trial, one number for each of the 10 possible numerical answers, with an X to be drawn through the appropriate number. *Ss* responded by marking one of 10 possible response categories with an X. Verbal feedback in the form of the correct answer was given at the end of each trial.

The 128 learning trials can be considered as 8 sets of 16 presentations each. Within every set of 16 possible combinations of x' and x'', each appears only once. This automatically made $r_{x'x''} = .00$. The distributions of y' and y'' were very close to rectangular: $r_{x'y'}$, $r_{x''y'}$, and $r_{x''y''}$ did not exceed .12 in any block. Thus, for practical purposes, these variables can be considered to be uncorrelated.

Criterion k. The formula used by *E* to define the correct response *k* is (2x' + x'')/3. Since x', y', x'', and y'' are uncorrelated within this set of stimuli, the definition of *k* determined their validities as follows: $r_{x'k} = .89$, $r_{x''k} = .45$, $r_{y'k} = .00$. The actual correlations of x' and x'' with *k* vary between -.12 and +.12. Since the 10 discrete response categories are exact numerical answers, *S* had to use precisely a 2 to 1 weighting to receive one hundred percent reinforcement.

Measures of performance. The basic measures of performance were the criterialities[1] of the individual cues and of the construct *k*: product-moment correlations coefficients of the actual responses of each *S* with the responses he would give if he were to make his judgments solely in terms of x', x'', y', y'', or *k*. This yields a 5 x 4 matrix of correlations for each *S*: rows for x', x'', y', y'', and *k*; columns for each block of 32 trials which were analyzed separately. Correlations were computed over four blocks of 32 trials--1-32, 33-64, 65-96, and 97-128, respectively.

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[1] Criteriality, according to Bruner, Goodnow & Austin (1956), means how much a cue is actually used by an *S*.

Results

Results are summarized in Tables 1 - 5.

The following conclusions about the experimental hypothesis were drawn:

1. The rank order of performance for the four groups was not as predicted, since the cue group performed better than the principle group. The difference between the two groups, however, was not significant.

2. A knowledge of the principle (principle group) is not more beneficial than a knowledge of the cues (cue group), although a knowledge of the principle together with a knowledge of the cues (full information group) leads to better performance; however, the final level of performance for the full information group is not statistically better than that of the cue group.

3. When the principle and cue groups are compared, a knowledge of the cue does not seem to be more beneficial initially, nor does a knowledge of the principle seem to be more beneficial later in learning; however, the groups who knew the principle (full information and principle groups) did learn the relative importance of the two relevant cues better than the other groups.

Table 1

Analyses of Variance on x', x" and k for Trial Block 1

Coordinate	Source[a]	MS	df	F
k	Knowledge of Principle	2.12	1	10.10***
k	Knowledge of Cues	1.96	1	9.33***
k	Interaction	1.20	1	5.71*
k	Within	.21	48	
x'	Knowledge of Principle	.58	1	4.14*
x'	Knowledge of Cues	.82	1	5.86*
x'	Interaction	.49	1	3.50
x'	Within	.14	48	
x"	Knowledge of Principle	.32	1	8.00**
x"	Knowledge of Cues	.14	1	3.50
x"	Interaction	.02	1	.50
x"	Within	1.93	48	

*Significant at .05 level.

**Significant at .01 level.

***Significant at .005 level.

[a] The principle and full information groups knew the principle; the cue and full information groups knew the cues.

Table 2

Analyses of Variance on x', x" and _k_ for Trial Block 2

Coordinate	Source[a]	MS	df	F
_k_	Knowledge of Principle	1.41	1	4.03
_k_	Knowledge of Cues	1.81	1	5.17*
_k_	Interaction	1.30	1	3.71
_k_	Within	.35	48	
x'	Knowledge of Principle	.23	1	1.44
x'	Knowledge of Cues	.34	1	2.12
x'	Interaction	1.03	1	6.44*
x'	Within	.16	48	
x"	Knowledge of Principle	.02	1	.33
x"	Knowledge of Cues	.00	1	.00
x"	Interaction	.25	1	4.17*
x"	Within	.06	48	

*Significant at .05 level.

[a] The principle and full information groups knew the principle; the cue and full information groups knew the cues.

Table 3

Analyses of Variance on x', x" and *k* for Trial Block 3

Coordinate	Source[a]	MS	df	F
k	Knowledge of Principle	1.39	1	2.24
k	Knowledge of Cues	2.38	1	3.84
k	Interaction	.11	1	.18
k	Within	.62	48	
x'	Knowledge of Principle	.27	1	1.08
x'	Knowledge of Cues	.13	1	.05
x'	Interaction	.07	1	.03
x'	Within	.25	48	
x"	Knowledge of Principle	.05	1	1.00
x"	Knowledge of Cues	.27	1	5.40*
x"	Interaction	.10	1	2.00
x"	Within	.05	48	

*Significant at the .05 level.

[a] The principle and full information groups knew the principle; the cue and full information groups knew the cues.

Table 4

Analyses of Variance on x', x" and k for Trial Block 4

Coordinate	Source[a]	MS	df	F
k	Knowledge of Principle	.76	1	1.29
k	Knowledge of Cues	4.05	1	6.86*
k	Interaction	.67	1	1.14
k	Within	.59	48	
x'	Knowledge of Principle	.20	1	.91
x'	Knowledge of Cues	.19	1	.86
x'	Interaction	.36	1	1.64
x'	Within	.22	48	
x"	Knowledge of Principle	.13	1	2.60
x"	Knowledge of Cues	.16	1	3.20
x"	Interaction	.12	1	2.40
x"	Within	.05	48	

*Significant at the .05 level.

[a] The principle and full information groups knew the principle; the cue and full information groups knew the cues.

Table 5

Results of Duncan's Multiple Range Tests for x', x'', and $\underline{k}$ over all Blocks of Trials

Coordinate	Block	Criterialities	Probability
$\underline{k}$	1	Full > No Information, Principle, Cues	$<.005$
$\underline{k}$	2	Full > No Information, Principle, Cues	$<.01$
$\underline{k}$	3	Full > No Information	$<.05$
$\underline{k}$	4	Full > No Information, Principle	$<.05$
x'	1	Full > No Information, Principle, Cues	$<.01$
x'	2	Full > Principle, Cues	$<.05$
x'	3	None	
x'	4	None	
x''	1	Full > No Information Full > Cues	$<.005$ $<.05$
x''	2	None	
x''	3	Cues > No Information, Principle	$<.05$
x''	4	Cues > Full, No Information, Principle	$<.05$

Experiment II

Amount of Information Conveyed by a Knowledge of Either the Principle or the Cues Given in Algebraic Form

Status: Report in preparation.

Purpose

Experiment I suggested that the presence of information about the task principle does no more to facilitate performance than does the absence of information, whereas information about the critical cues does facilitate performance. Furthermore, in a written questionnaire administered at the end of the task, many Ss verbalized their solutions of the task in a geometric form, whereas the original information was given in algebraic form. These verbalizations suggested that information given in geometric form might be more beneficial to the learner, since the geometric form of encoding seemed more parsimonious.

Hypotheses

1. Cue-information will lead to better overall group performance than principle-information, although a knowledge of both cue and principle is a requisite for criterion performance.

2. The rank order of performance will be full-information, cue-information, principle information and no information.

3. Whenever two groups are given the same information encoded in algebraic and geometric form, the group given the geometric encoding will perform better.

Method and Materials

Subjects

The Ss were University of Illinois students from the introductory psychology class. Their participation was the class requirement. The task was administered to Ss in groups that ranged in size from 3 to 20. With the larger groups, two or three Es helped with the administration. There were 15 Ss in each experimental group for a total of 120 Ss. There were seven groups in the basic design of this study (an eighth group was run in an auxiliary experiment which will be discussed). There was a no-information control group, and two sets of principle, cue, and full-information groups. One set was given information in algebraic form, the other in geometric form. This design allowed a comparison of principle vs. cue-information, and algebraic vs. geometric information.

Procedure

The task stimuli and presentations were the same as in Experiment I except that there were 160 stimuli, or trials, and Ss were paced. Twenty seconds were allowed for each trial.

Results

Seven different, but perfectly correlated, rules (or principles) were offered by Ss who solved the task. The types of rules they discovered could be easily related to the written instructions given before the task. It is clear that Ss do not benefit equally from the different content, or the differently encoded content, provided as pre-task information.

The correlational analysis of the data leads to the following conclusions about the experimental hypotheses:

1. There was an overall performance superiority of the cue-groups.

2. The predicted rank-order of performance was confirmed; i.e., full-information was best followed by the cue-information, and there were no significant differences between the principle-information and no-information groups. The likelihood of this rank order occurring by chance is less than .05.

3. There were no overall differences between the groups given the geometric and those given the algebraic information. However, the geometric groups tended to do a little better with full and cue-information and a little worse with principle-information.

Experiment III

A Comparison of Transfer Effects from Written Instructions Under Paced and Self-Paced Conditions

Status: Report in preparation.

Purpose

This study is basically a replication of some of the groups in Experiment II. The main difference is that in this experiment, each S worked at a teaching machine and, consequently, was self-paced. Therefore, comparisons were possible between a paced and a self-paced condition, with major emphasis on two variables: (1) trials to criterion, and (2) time to criterion.

Hypotheses

The following specific hypotheses were tested:

1. Since the self-paced condition allows each S to determine when he will respond (so that his progress may be slower in the early trials, for example, and faster later on) Ss in this experiment should attain criterion performance in fewer trials than comparable Ss in Experiment II.

2. Time to criterion should be facilitated in the self-paced condition, although the difference between pacing and self-pacing should not be as large in time as in trials to criterion.

Method and Materials

Subjects

The subjects were college students from a University of Illinois introductory psychology class in which participation in the experiment was a class requirement. No more than five Ss were run at a time, one per machine. A total of 60 Ss was divided into six experimental groups in this experiment: three groups were replications of the no-information and full-information (both algebraic and geometric) groups of Experiment II; the fourth group, also a full-information group, is comparable to the column-group in Experiment IV; the fifth and sixth groups were cue and principle groups for whom the information was given in terms of the column-group's model.

Procedure

Task stimuli. A black circle rather than a red cross, and a black cross rather than a green cross distinguish the task stimuli of this study from those of Experiments I and II. These changes facilitated filming for the teaching machine, and also eliminated the difficulty encountered by color-blind Ss.

Presentation of stimuli. Stimuli were presented on film by a teaching machine. Only one stimulus frame was seen at a time by the subject; the correct answer for each frame was given on the following frame. The S could return to the immediately prior frame to investigate any discrepancy between his answer and the correct answer. Therefore, the presentation of stimuli was equivalent to a straight linear program. Correction-procedure was not used.

Results

1. The superiority of cue information over principle information was again demonstrated.

2. If there is a difference between paced and self-paced conditions, it is slight. The difference appears to be in favor of the self-paced

condition and apparently is related to the opportunity to re-read complex frames during the task. Time data for each frame would be useful additional information to secure on this question.

3. The column-model appears to be a simpler encoding than the algebraic or geometric models used in Experiment I. That is, Ss given information in terms of this model use the information as given and do not manifest the transformations of information to simpler terms that were discovered in Experiment I.

Experiment IV

Some Perceptual and Verbal Factors in the Transfer from One Task to Another Generated from the Same Model

Status: Data in process.

Purpose

When the verbalized rules of the solvers in Experiment II were examined, seven categories were established. These verbalizations ranged from general and abstract to very specific and concrete. If different verbalized rules mean that the Ss have learned different "concepts" (intraverbal behavior), even though their overt behavior is the same, then differences in transfer to a second task should occur. This experiment is designed to see whether or not this is a useful conception. It relates the statements made by the Ss at the end of Task 1 to their performance on Task 2.

Hypotheses

The following specific hypotheses were tested:

1. The rank-order predictions of the Ss relative rate of learning to solve Task 2 can be made from a comparison of the verbalized rules used by Ss in Task 1 with the rule they must learn to solve Task 2.

2. Perceptual similarity of the cues in each task should lead to faster solution of Task 2 than perceptual dissimilarity of the cues.

3. When the stimuli of two tasks are not obviously similar, and Ss do not suspect that the two tasks are related, the group given instructions which state that the two are related should learn Task 2 more rapidly than the group not given instructions.

4. When two tasks are perceptually dissimilar, the predicted transfer effects should occur only among those Ss who consciously relate the two tasks. The behavior of Ss who do not consciously relate the two tasks should not be distinguishable from that of the Ss in the control group.

Method and Materials

Subjects

Five Ss were run in each cell for a total of 60 experimental Ss. There were four groups, one for each of four sets of instructions or rules, with 15 Ss in each group. A control group of 20 Ss was also run, half of which solved Task 2 with one of the formulae and half with the other (formula A or B). The control group was allowed to warm up on a neutral memory task before working on Task 2A or 2B.

Procedure

Task stimuli. The training task in this experiment was essentially the same as the task used in Experiments I, II and III. There were two minor changes:

1. As in Experiment III, a small black circle and a small black square replaced the red cross and green cross used in Experiments I and II.
2. The stimuli were presented to Ss on individual cards.

The transfer task used 3 x 5 stimulus cards on which there was a circle, square, triangle, and rhombus. One of the following four numerals was printed within each geometrical figure: 1, 2, 3, or 4. The numerals within the figures replaced the four discrete coordinate values that the circle and square could assume in the training task. As in the training task, only two of the four figures were relevant. The correct rule to obtain k (criterion response) was the sum of two products obtained by weighting the values in two of the figures. Either one of the following alternatives, both involving a two and one weighting, would work: (a) 2 (number in the circle) + 1 (number in the square), or (b) 2 (number in the triangle) + 1 (number in the rhombus).

Four tasks, two training and two transfer, were actually used, designated 1A, 1B, 2A, and 2B. The Arabic numeral represents the stimulus encoding: 1 stands for the displays with the circle and square that varied their positions in a field; and 2 stands for the displays with the circle, square, triangle and rhombus containing numerals from 1 to 4. The letters stand for the weighting principle required to secure the correct k values. In each case, the change from A to B signifies a reversal shift.

Presentation of stimuli. Four sets of instructions or rules were presented to four groups of Ss: (1) full-information row [k = 2 (row of the circle) + 1 (row of the square)]; (2) full-information column [k = 2 (column of the circle) + 1 (column of the square)]; (3) full-information algebraic; and (4) a solution in which the 2:1 weighting was only implicit. These sets of instructions were suggested by the verbalizations of the subjects in Experiment II; in this sense, the instructions given were second generation solutions to the problem.

Within each group of Ss (N = 15 for each group) there were three types of transfer treatments which were differentiated by (1) correct formula; and (2) knowledge of the relatedness of the two tasks. The three treatments were (1) the correct formula, 2 (number in circle + 1 (number in square);

(2) the correct formula, and a hint that the training and transfer tasks were related. This generated a 4 x 3 factorial design with both factors fixed.

After the S read one of the sets of instructions, the E presented the stimulus frames for Task 1A one at a time. The S gave his numerical response for the value of k, and also the rule he was using on each trial. This procedure was repeated in Task 1B also, in which the only difference was the formula used to assign weights. This made Task 1B a reversal shift of Task 1A. The S was not informed that a switch was being made, nor was he allowed to ask questions at the time. This switching of rules was included to investigate the transfer effects of a first reversal shift to a second one. After solving the first task (1A) and its shift (1B), the subject was read the instructions for Task 2A and began it immediately. After reaching criterion on 2A, the formula was again changed and S began Task 2B, a reversal shift of Task 2A. Post-experimental interviews were conducted after each task.

Results

The data for the study have not been completely processed, but the following conclusions (see Figure 1) can be made:

1. Hypotheses 1, 3, and 4 were confirmed.

2. The conclusion about hypothesis 2 is not clear. It seems that the perceptual similarity of cues facilitates transfer performance if the verbalized principles of solution are similar for the two tasks, but that it has no noticeable effect on transfer if the verbalized principles are not similar. Thus, the form of the intraverbal behavior seems critical.

The way in which the stimulus display is encoded by the learner can be an important factor in determining the degree of transfer of training that results.

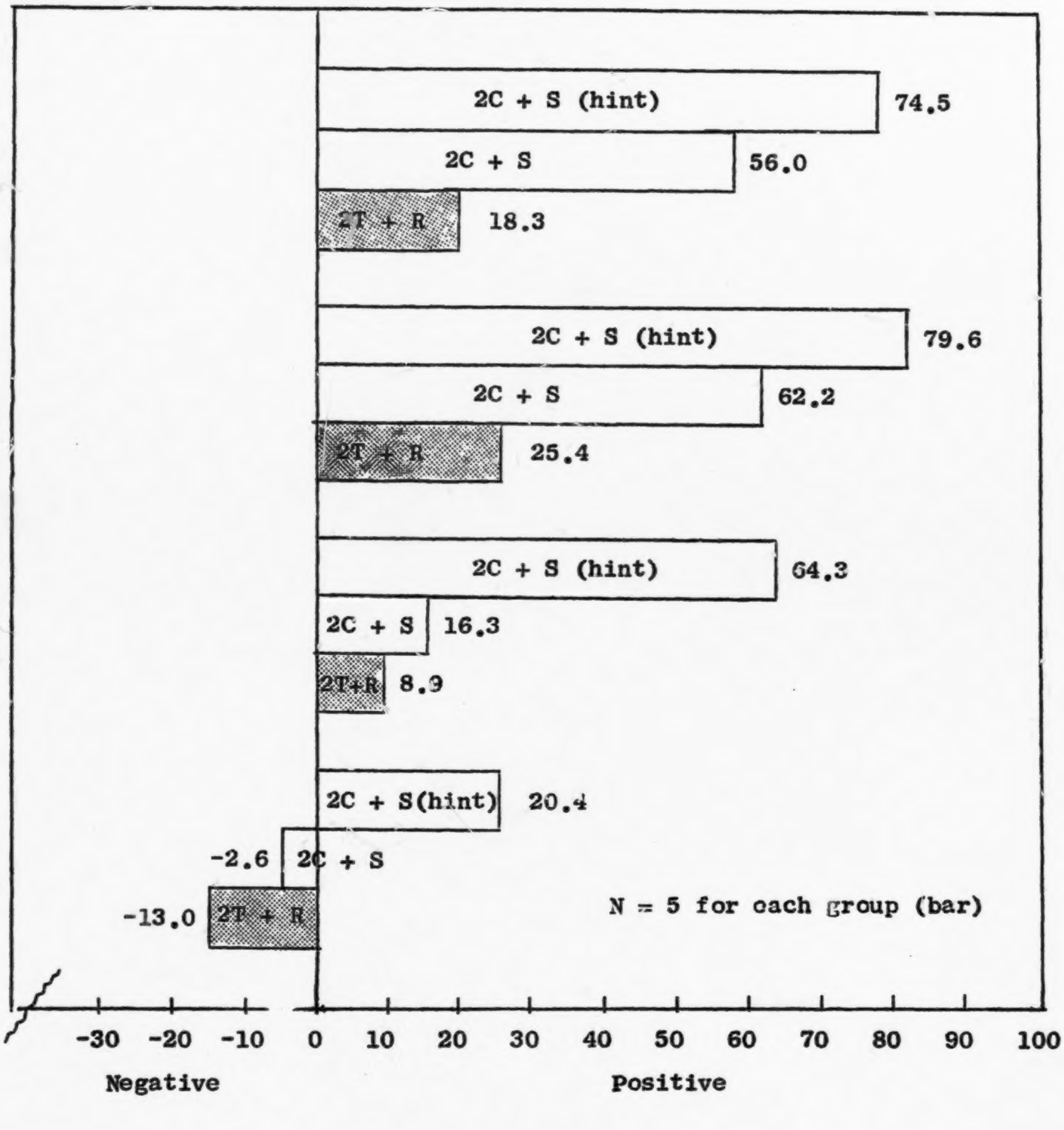

Fig. 1. Percentage of Transfer on Second Task for Each Group Taught One of Four Different Rules.

[a] Solution = 2 times the number in the circle plus one times the number in the square (2C + S) or two times the number in the triangle plus 1 times the number in the rhombus (2T + R). One group was given a hint that the training and test tasks were related to each other. The baseline represents appropriate control group performance (2C + S or 2T + R) from which transfer was computed using formulas 1 and 2 in Gagne, Foster, and Crowley (1948).

Experiment V

Some Perceptual and Verbal Factors in the Transfer From One Task to Another Task Generated From the Same Formula

Status: Data collected.

Purpose

Two problems were encountered in Experiment IV: (1) the need for concurrent measures of transfer (indicating an awareness that it is occurring) rather than after the fact measures of transfer (indicating that the task is solved); and (2) the difficulty of handling negative transfer when intra-task hints are given since the use of negative elements is systematically eliminated by these hints. Therefore, a larger experiment was conducted in which Ss were encouraged to "think aloud". The experiment was so designed that transfer, if it occurred, would be positive.

Hypotheses

The following specific hypotheses were tested:

1. When the stimuli of two tasks are not obviously similar (perceptually dissimilar), and Ss may not suspect that the two tasks are related, instructions stating that the two are related should facilitate the speed of solving Task 2.

2. When two tasks are perceptually dissimilar, and no hint of their relationship is given, the predicted transfer effects should occur only among those Ss who consciously relate the two tasks. The performance of Ss who do not consciously relate the two tasks, should be indistinguishable from the

performance of Ss in the control group in (a) trials to criterion, (b) type of solution discovered, and (c) the process by which solution is attained.

Method and Materials

Subjects

There were 28 Ss in each condition without knowledge of the relatedness of the two tasks, and 20 Ss in each condition with such knowledge for a total of 96 experimental Ss with an equal number of males and females in all conditions. A control group of 32 Ss was also included.

Procedure

Task stimuli. The training task was identical to that used in Experiment IV. The following modifications of the stimuli for the transfer task were made:

1. The task was so designed that any S could discover any of three solutions.

2. Pilot work indicated that positions were infrequently used if position numbers were not included below the figures, so these numbers were added.

Presentation of stimuli. The two sets of instructions for Task 1 were (1) full-information in terms of column (identical to that in Experiment IV), and (2) a solution in which the 2:1 weighting was not explicit:

> 3 (column of the circle) ± the number of columns from the circle to the square (+, if the circle is to the left of the square; - , if the circle is to the right of the square).

This latter set of instructions is very similar to set four in Experiment IV. After the S read one of the two sets of instructions, he answered a set of questions designed to assess whether or not he understood the instructions. If S gave evidence of misunderstanding, E attempted to clarify the instructions. Then the stimuli for Task 1 were presented one at a time. The S gave his numerical response and the rule he was using on each trial in both tasks. He was encouraged to "think aloud" during both tasks. Since the purpose of the first task was to teach S a rule, E attempted to explain what S was doing wrong if he made mistakes during the task.

After solving the first task, the S was read the instructions for Task 2 and began it immediately. The transfer task conditions were differentiated by knowledge of the relatedness of the two tasks. The transfer task was so designed that any of the three following formulas would generate the criterion responses: (1) 2 (position of the circle) + 1 (position of the square); (2) 3 (position of the circle) ± the number of positions from the circle to the square; (3) 2 (number in the triangle) + 1 (number in the rhombus).

The controls were divided into two equal groups. One of these was given "easy" items of the Raven's Progressive Matrices test (1956), the other was given "difficult" items to produce a set in S for an easy or a difficult task. The experimental Ss who were given pretraining rule 2, were assumed to have a more difficult Task 1 condition than those who were given pretraining rule 1. Consequently, two different controls seemed indicated. Subtests A, B, and C of the Raven's Progressive Matrices test were used to create the "easy" warm-up task and subtest D and E were used to create the "difficult" warm-up task. A post-experimental interview was conducted after Task 2 to all Ss.

Results

The results of the transfer task were analyzed in terms of three dependent variables: (1) trials to criterion; (2) type of solution verbalized; and (3) various measures of the learning process. On the basis of both spontaneous verbalizations during the task and answers to questions during a post-experimental interview, Ss were categorized into those with or without transfer hypotheses and transfer intentions. The following tentative conclusions can be made:

1. With trials to criterion as the dependent variable: (a) only knowledge of the relatedness of the two tasks was a significant variable; (b) neither type of pretraining rule nor (c) sex made a significant difference. Figure 2 presents graphically the amount of transfer (from mean trials to criterion) for Ss given or not given a transfer hint. Figure 3 presents the amount of transfer for Ss reporting or not reporting a transfer hypothesis or a transfer intention. The mean trials to criterion for the control groups was 18.5.

2. Type of solution verbalized made a difference both in the type of solution discovered and in the process of solution for the second task.

3. When Ss who did not report a transfer intention are compared with control Ss, the following additional results are indicated by various measures of the learning process: (a) though conscious (verbalized) relating of the two tasks accounts for the bulk of positive transfer, data indicate that a small amount of unconscious transfer (not verbalized) did occur; (b) four of the former solved the transfer task without any task hints, none of the controls did; (c) there seemed to be more guessing (offering no formula), less use of two cues, and less use of position cues among the controls.

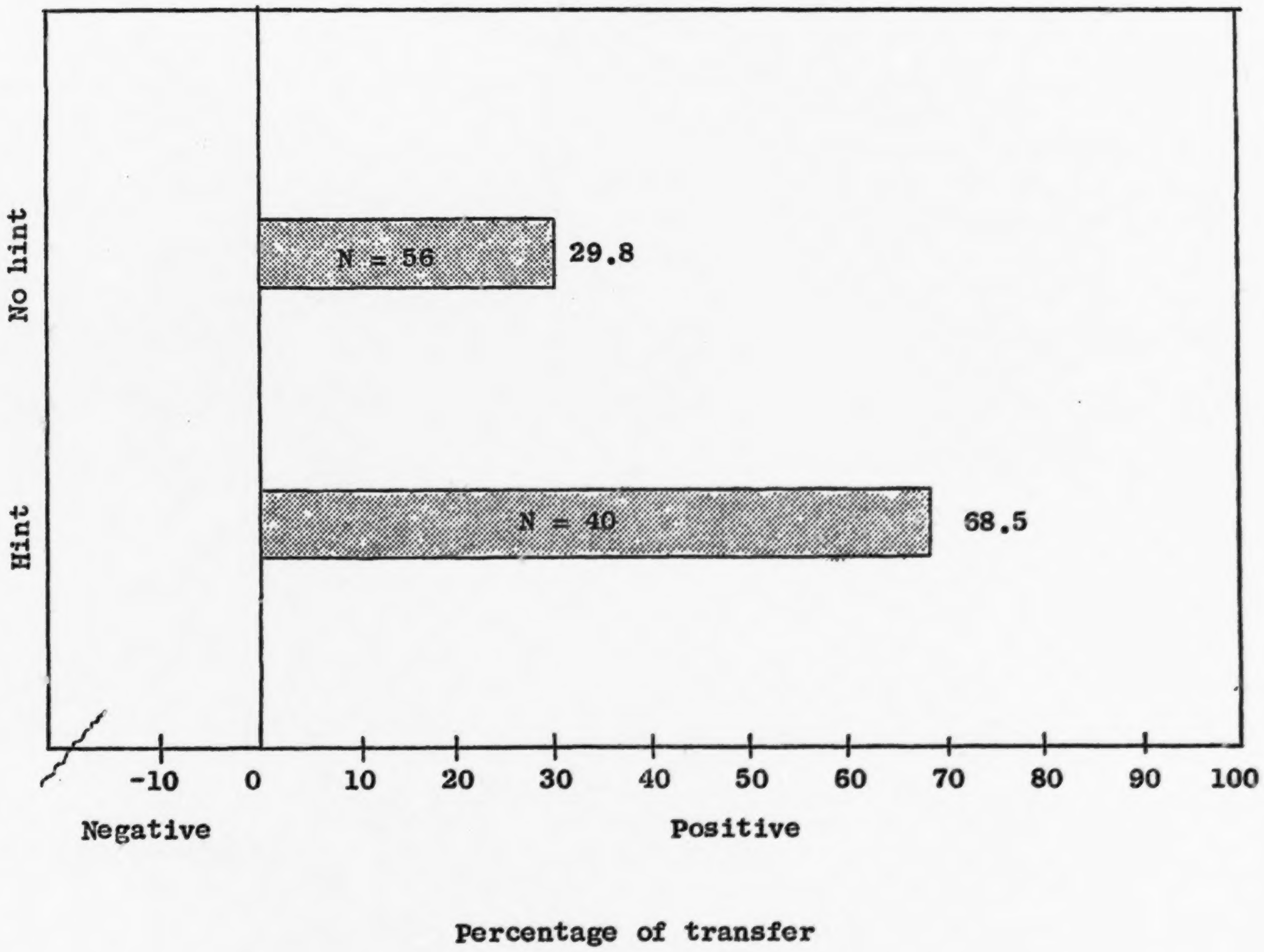

Fig. 2. Percentage of Transfer on the Second Task for Groups Receiving a Hint and Not Receiving a Hint that the Two Tasks were Related.[a]

[a] Transfer was computed using formulas 1 and 2 in Gagné, Foster and Crowley (1948).

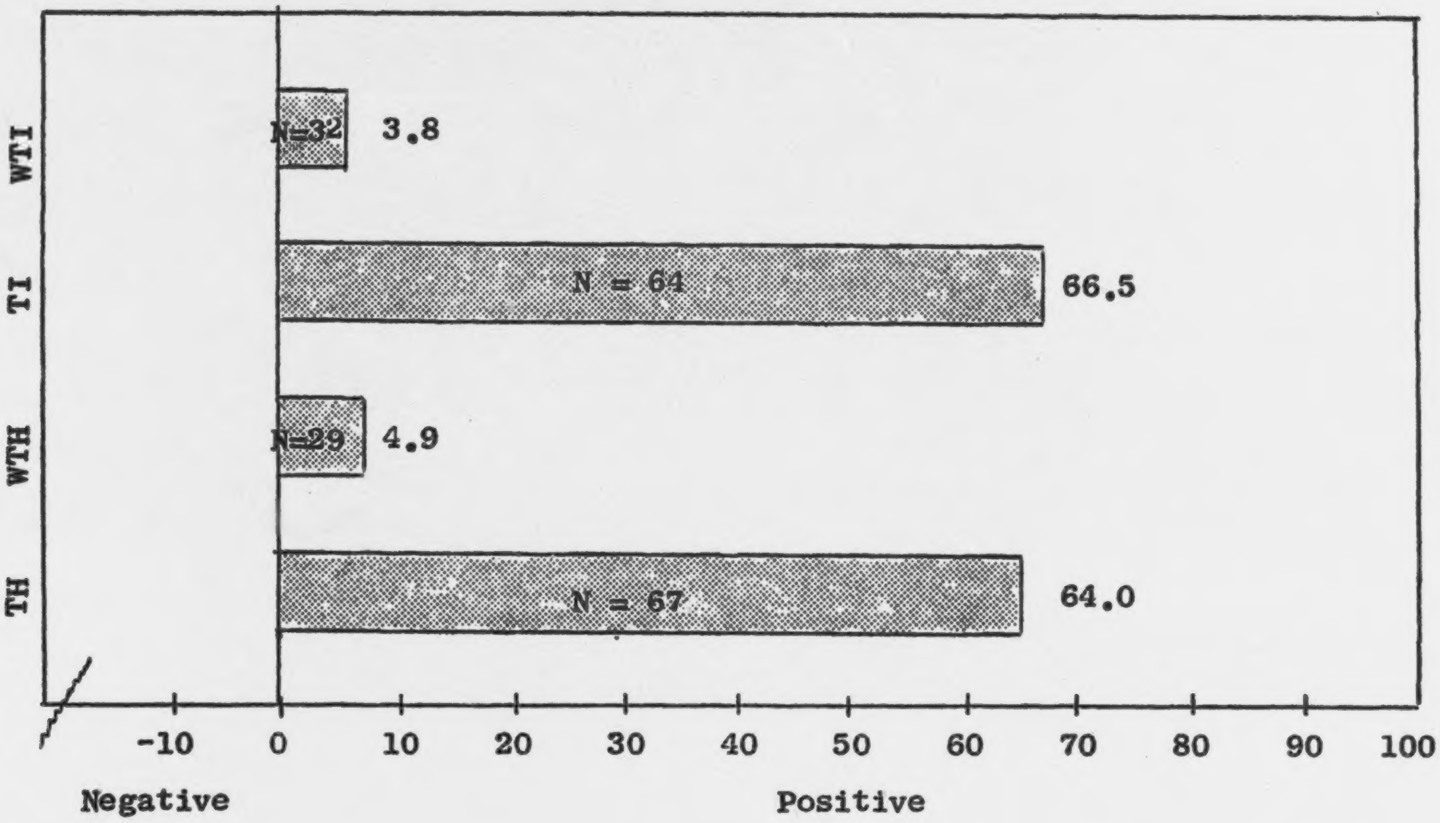

Fig. 3. Percentage of Transfer on Test Problems for Ss with Transfer Intentions (TI), Without Transfer Intentions (WTI), with Transfer Hypotheses (TH), and Without Transfer Hypotheses (WTH).[a]

[a] Transfer was computed using formulas 1 and 2 in Gagné, Foster and Crowley (1948).

Experiment VI

Learning How to Learn Under Several Cue Conditions[2]

Status: COMPLETED -- Dale Mattson. Learning How to Learn Under Several Cue Conditions. Technical Report No. 1, August, 1963.

Purpose

The objectives of this experiment were (1) to determine the effects of several kinds of training on the subsequent mastery of a modified form of a problem solving task developed by Azuma (1960) and (2) to evaluate the usefulness of cue-response criterialities in explaining transfer effects.

Hypotheses

1. Three kinds of transfer effects can be identified and compared: (a) an effect associated with cue repetition; (b) a learning-to-learn effect; and (c) a warm-up effect.

2. Cue repetition is expected to result in a negative effect under a condition in which relevant cues during training become irrelevant during the criterion task(similar to a nonreversal shift), and a positive effect under a condition in which the same cues are relevant for both training and the criterion task.

3. On the first trial of the transfer task, single-trial criterialities will be higher for cues previously relevant than for cues previously irrelevant.

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[2] This experiment was done by Dale Mattson in partial fulfillment of the requirements for a Ph.D. degree and is on file at the University of Illinois Library.

Method

Subjects

The _S_s for this experiment were undergraduate college students. For the first experiment, in which large group testing procedures were used, the _S_s participated in the experiment as part of a course requirement. For the second experiment, all _S_s volunteered to take part.

Procedure

The design of this study was a factorial design involving two degrees of similarity between the training task and the criterion task, and three degrees of similarity between the cues used for the training task and those used for the criterion task. In addition to the six groups (16 _S_s per group) necessary for this design, an additional group of 16 _S_s was used as a control group that performed only the criterion task. The entire experiment was duplicated -- once using large group testing procedures and once testing groups of either 7 or 14 at a time.

Results

The results of the experiment may be summarized as follows:

1. A learning-to-learn effect was identified. Those _S_s who received training on a series of training tasks that were similar to the criterion task solved the criterion task in fewer trials than _S_s who received training tasks that were not similar to the criterion task.

2. No transfer effect was found for the similarity of cues between the training tasks and the criterion task. For some _S_s, relevant and irrelevant

cues remained constant for all tasks; for some Ss, relevant and irrelevant cues were reversed on the criterion task; and for some Ss, completely new cues were introduced during the criterion task. The number of trials needed to solve the criterion task was not affected by any of these three cue conditions.

3. A warm-up effect was identified. Ss who performed a series of four tasks quite different from the criterion task, using four cues unlike those used on the criterion tasks, solved the criterion task in fewer trials than Ss in the control group.

4. The use of the same two cues in the solution of a number of training tasks resulted in an increased use of these cues on the first trial of the criterion task. The criteriality (correlation) between cues and responses was higher, on the first trial of the criterion task, for cues which previously had been relevant than for cues which previously had been irrelevant.

Experiment VII

The Effects of Sequence and Structure on Complex Concept Formation

Status: COMPLETED -- Daniel J. Davis. The Effects of Sequence and Structure on Complex Concept Formation, Technical Report No. 4, January, 1964.

Purpose

Since there are several different principles that can be invoked in structuring or sequencing the training trials of a task, it is important to know the transfer effects produced by the different principles. In this study, four groups of Ss were given different training conditions, as specified by four different principles, in order to determine the effects produced in the learning of a transfer task.

Hypotheses[3]

Three questions were examined:

1. What is the effect of adding asynchronous (A) trials?

2. What is the best order of presentation of asynchronous (A) and synchronous (S) training trials?

3. During the asynchronous trials, is it better to vary the relevant cue first?

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[3] See Detambel and Stolurow (1956) for a definition of asynchrony and synchrony.

Method

Subjects

Eleven subjects in each of four treatments were obtained from an introductory psychology course at the University of Illinois. Participation was part of the course requirement.

Procedure

Asynchrony refers to the relationship between the pattern of stimulus changes from trial to trial. For example, if stimulus element A changes from A to A' in going from Trial 1 to Trial 2, and if element B changes from B" to B, then both elements have changed on that pair of trials, and therefore may be described as synchronous. However, if element C stayed the same on the two trials, it would have been asynchronous with both A and B. Thus, asynchrony occurs whenever one element changes from one trial to the next and the other element does not. Synchrony, on the other hand, occurs whenever both elements change on two adjacent trials, as in the example with elements A and B, and whenever neither element changes on two adjacent trials.

Several ways of structuring and sequencing the early trials of a complex task were compared. Four experimental groups received both structured (asynchronous) and unstructured (synchronous) training trials. The asynchronous trials were divided into two segments: A-MAX (the more relevant cue was free to vary) and A-MIN (the less relevant cue was free to vary). The four experimental conditions were generated by the different sequential orders of presenting the structured and unstructured trials (A-S vs. S-A) as well as the two types of asynchronous trials (MAX-MIN vs. MIN-MAX). A control group received only unstructured (synchronous) training.

Table 6

Experimental Design and Conditions[a]

Group	N	Training task Trials 1-32	 Trials 33-64	Transfer task Trials 65-160
Exp. 1	11	A(MIN-MAX)	S	S
Exp. 2	11	A(MAX-MIN)	S	S
Exp. 3	11	S	A(MIN-MAX)	S
Exp. 4	11	S	A(MAX-MIN)	S
Control	11	S	S	S

[a] S = synchronous or structured training.

A(MIN-MAX) = asynchronous or unstructured training in which the less relevant cue was free to vary during the first 16 trials of a trial block and the more relevant cue was free to vary during the last 16 trials of a trial block.

A(MAX-MIN) = asynchronous or unstructured training in which the more relevant cue was free to vary during the first 16 trials of a trial block and the less relevant cue was free to vary during the last 16 trials of a trial block.

The task was the same as used by McHale and Stolurow (1962). Each S was given 160 presentations in five blocks of 32 trials. The design used is presented in Table 6.

Results

A significant learning effect was found ($F = 24.4$, for 2 and 80 df, $p < .04$). Asynchronous training did not result in a significantly higher level of performance. This lack of difference may be due to the lack of generalized learning due to training on only one member of the class of asynchronous blocks and/or the over-emphasis of the less relevant cue.

For the experimental groups, it was found that the presentation of synchronous training trials prior to asynchronous training (Groups 3 and 4 in Table 6) did not improve performance. Therefore, the hypothesis that this type of training would aid transfer by familiarizing Ss with the transfer task prior to asynchronous training was not confirmed.

It was found that presenting a sequence in which the maximally pertinent cue varied first (A-MAX condition, Experimental group 2) led to improved transfer task performance ($F = 4.4$, for 1 and 40 df, $p < .05$). This is an indication that the order of training in a complex task should proceed from the more relevant to the less relevant aspects (Experimental groups 1 and 2). (See Figures 4 and 5).

Further Research

The conclusions arrived at in this experiment will serve as the basis for future investigations. In particular, the following questions are of interest:

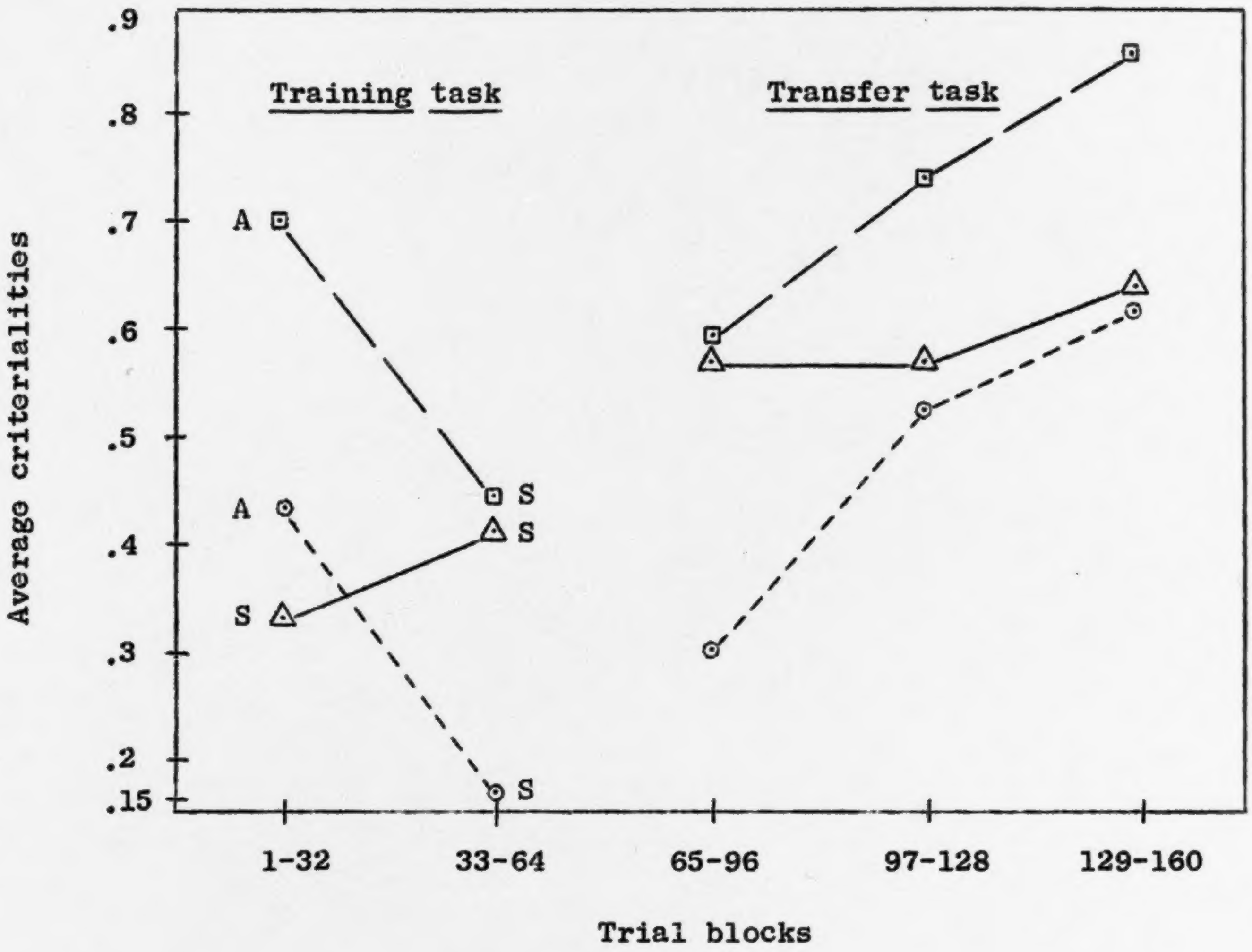

Fig. 4. Average Criterialities of the A-S Groups and the Control Group.

KEY

△ = Control
⊙ = Exp. 1 (Min-Max)
⊡ = Exp. 2 (Max-Min)

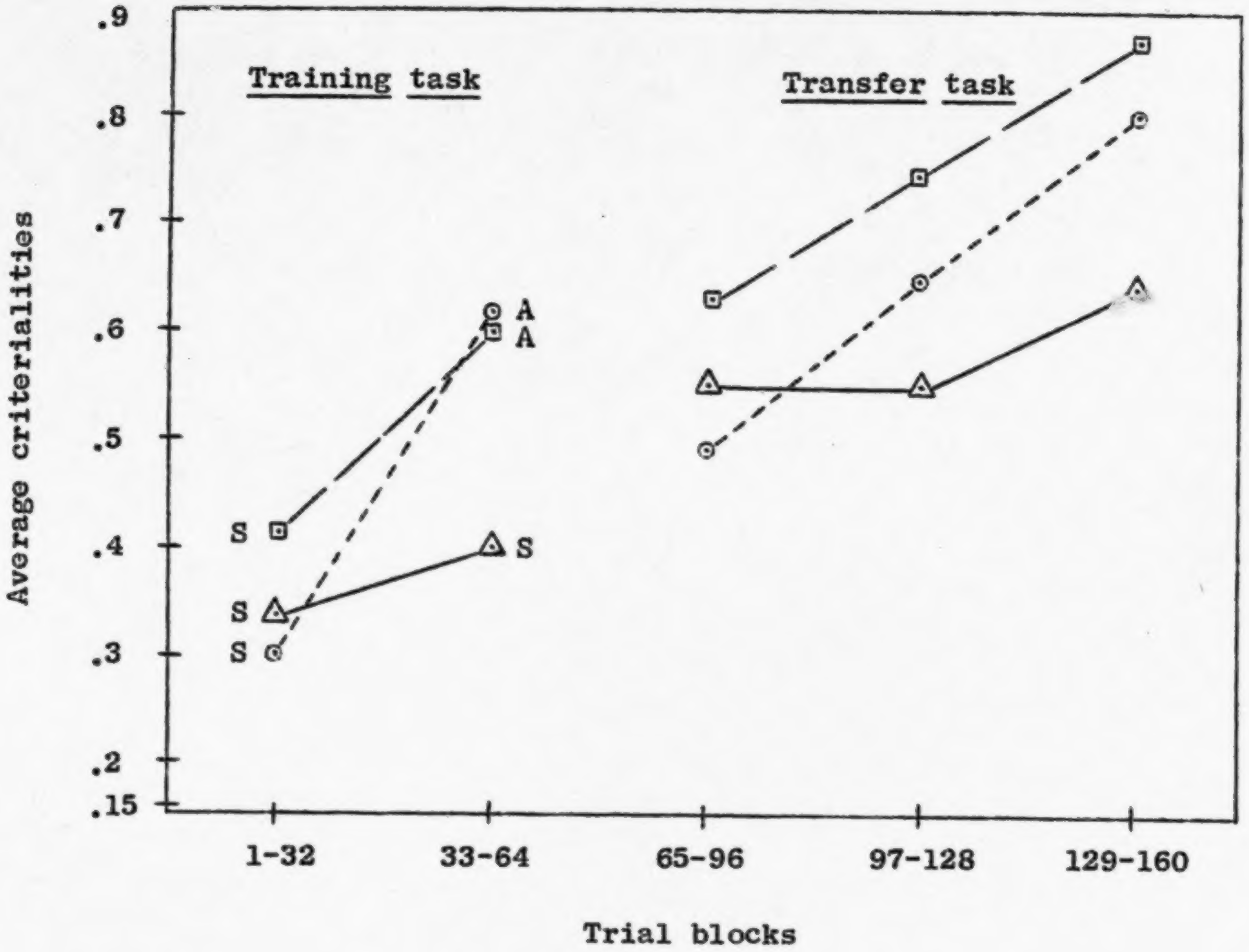

Fig. 5. Average Criterialities of the S-A Groups and the Control Group.

KEY

△ = Control
⊙ = Exp. 3 (Min-Max)
⊡ = Exp. 4 (Max-Min)

1. How does the type of asynchronous training affect transfer? It is expected that asynchronous training which involves only maximally pertinent cues would be superior to that which involves only minimally pertinent cues.

2. How does the amount of asynchronous training affect transfer? There are several issues here. First, there is the question of how much training should be given for each type of asynchronous block (e.g., keeping the cross in a fixed position for a block of trials while the circle varies from column to column. Second, there is the question of how many types of asynchronous blocks should be presented for optimum transfer. These two questions relate to the multiple problem training issue as discussed by Morissett and Hovland (1959). Third, there is the question of apportioning training among the more pertinent aspects. Is it better to decrease the amount of training for the less pertinent aspects of a problem as compared with the more pertinent aspects? There is some slight evidence that this is the case; however, a direct test of this hypothesis is necessary before a definite conclusion can be made.

3. How does the order of asynchronous training affect transfer? It was demonstrated in this experiment that transfer is greater when the more pertinent cue is allowed to vary first. This suggests that there is an order relationship in training which is based on the relevancy of the aspects. That is, the more relevant or pertinent aspects should be presented first. This should be demonstrated in the case of three or more aspects, each differing in its relevancy to the solution, before this order effect is accepted.

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Chapter III

Study of the Learning and Transfer Effects Related to Instructional Variables and Test Conditions in Logic

L. M. Stolurow, L. T. Frase, J. Odell, J. Zartman, J. Kearns, and G. Marco

A series of transfer experiments is being conducted utilizing self-instructional materials in an introductory logic course at the collegiate level, developed in the Training Research Laboratory.

Experiment I had both a substantive and a methodological purpose. The substantive purpose was to determine the relationship between personality (test anxiety) and ability traits, and the learning of introductory logic; the methodological purpose was to compare performance on open- and closed-book examinations.

Experiment II assessed the different effects of linear and branching programs upon the acquisition and retention of formal logic in terms of both knowledge and application test items.

Experiments III and IV revealed the systematic effect of congruous and incongruous conclusions upon syllogistic reasoning, demonstrating that verbal responses negatively transfer to reasoning,and that atmosphere and incongruity negatively effect judgments of the validity of syllogisms by Ss without training.

Experiment V attempted to determine the effects of two different formal symbolic notations (Peano-Russell and Polish) upon the acquisition and transfer of the knowledge and application of propositional logic.

Experiment I

Psychological and Psychometric Correlates of Achievement Test Modes[1]

Status: Data being analyzed.

Purpose

Achievement, at least in part, can be thought of not only as the transfer of learning or abilities, but also dispositions that are known through S's personality traits. These traits can be distinguished from those in the cognitive domain (see Bloom, 1956). This experiment has both a substantive and a methodological purpose with respect to the prediction of learning, retention, and transfer effects from external (anchor) measures, which represent the domains of human behavior.

The substantive purposes are (1) to relate ability and personality traits to the learning of introductory logic, and (2) to determine the psychological characteristics involved in learning this type of subject matter. More specifically, the experiment will test hypotheses regarding the relationship of test anxiety to student performance under two conditions of achievement measurement (open- and closed-book testing).

The methodological purposes are (1) to determine whether testing techniques will distinguish the performance on open-book examinations from the performance on closed-book examinations, and (2) to determine the problems of measuring achievement in the programed learning of logic.

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[1] This study was conducted by Gary Marco as a part of his doctoral dissertation research under the supervision of Professor Thomas Hastings, University of Illinois.

Hypotheses

1. It is possible to account for most of the variance in learning, transfer, and retention scores in logic with anchor tests, presumed to represent the cognitive and affective domains.

2. If achievement in programed logic depends on specific abilities and personality traits, then a set of factors determining achievement in logic will be found. If achievement in each of the two test conditions depends on different traits, then a factor representing each condition will appear. In other words, the accountable variance will be distributed differently between the two domains under different conditions of testing (open- and closed-book).

3. Anchor tests of test anxiety, representing the affective domain, will account for different proportions of the learning, retention, and transfer score variance under open- and closed-book testing.

4. Learning, retention, and transfer score variance in logic represent traits in the cognitive and affective domains.

Method

Subjects

Ss for this experiment were 160 students from Educational Psychology 211 classes at the University of Illinois.

Procedure

Ss studied a series of programed textbooks in logic. In order to discover the psychological meaning behind achievement under the two conditions, a set of anchor tests from Guilford's cognitive battery and temperament survey were selected to measure various cognitive and affective traits. A set of achievement test scores was secured by using the Ss achievement test scores in three areas of educational psychology and one area of logic (both open- and closed-book scores were obtained during the same testing period).

In order to evaluate achievement in programed learning (in relation to cognitive and affective traits) under each of the two test modes, all of the correlations between variables (personality and achievement) will be factor analyzed.

Results

Data are being analyzed.

Experiment II

Learning and Transfer Effects of Linear and Branch Programs in Logic

Status: Report in preparation

Purpose

One purpose of this experiment, which uses a branching, self-instructional program in logic, was to study some of the ways in which the learning of logic transfers to problem solving. For this purpose, problem solving is defined by test items requiring the application of concepts taught by the program.

The second purpose was to compare the performance of _S_s who studied the same self-instructional programs while enrolled in courses of different subject matters. _S_s were enrolled in both logic and speech courses. The third purpose was to determine the relationships among scores (learning, retention, and transfer).

Hypotheses

1. Different programs (minimum linear, maximum linear, and branching) will produce differences in performance.

2. The additional relevant information provided by the teacher of the logic courses will not produce differences in the performance of _S_s on tests of knowledge and application.

Method

Subjects

A total of 141 Ss enrolled in an introductory course in philosophy were assigned to three groups.[2] Twenty-three students enrolled in a speech course were included for an additional comparison.

Procedure

The independent variables under investigation, in relation to learning and transfer, were three presentation patterns (instructional strategies) of the logic program. The program and its branches were prepared by having the programer (an experienced teacher) insert additional materials into the program that students read if they made an incorrect response. All Ss first read the material in Book I, after which those in each class were randomly assigned to different versions of Books II and III, respectively. Each S received either a maximum linear, a minimum linear, or a branched version of the program to study.

Dependent variables were (1) pretest scores on knowledge and application of logic, (2) errors made in the program, (3) scores on a review test, (4) scores on a posttest of logic, (5) gains made on application items (pretest-posttest differences), and (6) gains made on knowledge items (pretest-posttest differences). In addition to (5) and (6) above, two measures of gain were used: (a) pretest-immediate posttest, and (b) immediate posttest-delayed.

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[2] The N of subjects changes slightly due to students who were absent at various points in the experiment.

Four weeks after they worked on the program, a delayed posttest was given to approximately one-half of the students in the philosophy classes, and all of the students in the speech class.

Results

Comparison of Linear and Branching Programs

Analyses of variance indicated that there were no significant differences, on pretest measures of logic performance or on any of the dependent variables obtained after learning, between groups who used either the branching, maximum linear, or minimum linear programs. These data indicate that the groups performed equally well with all three of the programs, which raises serious doubts about the ability of even experienced teachers to judge the effectiveness of remedial materials.

Comparison of Speech and Logic Classes

Pretests of logic indicated that the speech class initially did not differ significantly from the philosophy classes. In fact, all groups were comparable initially (see Table 1). However, the speech class was significantly lower than the philosophy class on the posttest of logic (on both knowledge and application items). Although all groups learned, the speech students learned less than the philosophy students. They were significantly lower in the amount they gained (posttest minus pretest scores), but only on the knowledge items. These results are summarized in Tables 1 - 7.

From these results it seems reasonable to conclude that the philosophy classes were superior in their knowledge of logic. This result can be

Table 1

Means and Standard Deviations for Logic Pretest Scores

Groups	N	Logic pretest					
		Total		Application		Knowledge	
		M	S.D.	M	S.D.	M	S.D.
Philosophy 1	44	42.89	5.7	28.43	4.6	13.95	2.35
Philosophy 2	47	43.32	5.4	28.84	5.1	14.66	2.54
Philosophy 3	50	42.60	4.7	28.64	4.0	14.26	2.32
Speech	23	43.39	18.7	27.43	12.2	16.21	7.00

Table 2

Means and Standard Deviations for Logic Posttest Scores and Gain Scores

Group	N	Logic Posttest						Gain Scores					
		Total		Application		Knowledge		Total		Application		Knowledge	
		M	S.D.	M	S.D.	M	S.D.	M	S.D.	M	S.D.	M	S.D.
Philosophy 1	44	22.57	6.75	29.16	5.06	51.73	3.18	8.02	5.65	.32	4.41	8.52	3.38
Philosophy 2	47	23.09	7.65	28.28	5.45	51.57	3.22	8.84	5.50	-.38	4.36	8.64	4.30
Philosophy 3	50	22.62	6.90	28.76	4.73	51.38	3.21	8.26	5.63	.44	3.75	8.36	3.69
Speech	23	17.22	26.70	23.22	16.30	40.43	12.37	4.30	7.95	1.22	4.76	3.48	3.65

Table 3

Analysis of Variance for the Posttest Knowledge Items

Source	SS	df	MS	F
Between	614.80	3	204.93	6.86*
Within	4780.15	160	29.88	
Total	5394.95	163		

*Significant at .001 level

Group means are in Table 2.

Table 4

Analysis of Variance for the Posttest Application Items

Source	SS	df	MS	F
Between	617.28	3	205.76	3.49*
Within	9432.33	160	58.95	
Total	10049.61	163		

*Significant at .01 level.
Group means are in Table 2.

Table 5

Analysis of Variance for the Total Posttest Scores

Source	SS	df	MS	F
Between	2447.34	3	815.78	5.31*
Within	24573.65	160	153.59	
Total	27020.99	163		

*Significant at .001 level.

Group means are in Table 2.

Table 6

Analysis of Variance for the Gain Scores (Knowledge Items)

Source	SS	df	MS	F
Between	501.27	3	167.09	11.618*
Within	2301.09	160	14.38	
Total	2802.36	163		

*Significant at .001 level.

Group means are in Table 2.

Table 7

Analysis of Variance of Total Gain Scores

Source	SS	df	MS	F
Between	378.67	3	126.22	3.53*
Within	5722.27	160	35.76	
Total	6100.94	163		

*Significant at .001 level.

Group means are in Table 2.

attributed to further class experience in logic beyond the subject matter of the programed logic texts used in the experiment. The significant differences in knowledge without commensurate gains in performance on application items indicate that, although students in philosophy may gain more in knowledge of the subject matter with which they deal in class, philosophy students do not necessarily make superior gains (relative to groups not studying philosophy) on items which involve transfer (application items).

Intercorrelations

Pretest. The application subtest scores of the pretest were correlated with learning, retention, and transfer measures to determine whether they (1) were equally effective, (2) would predict subsequent performance, and (3) would predict differently under the different learning conditions.

The pretest application items were better predictors than the knowledge items of the number of errors that the student would make in the program. Ss who earned high scores on application items of the pretest tended to make fewer errors on the program than those who earned low scores (see Table 8).

Immediate posttest: Review test. Errors in the program were more highly correlated with application items on the posttest than they were with the errors in the program. For Book I, the correlation was -.38, for Book II, -.37, and for Book III, -.49 (N = 161) (see Table 8).

Delayed posttest. Errors in the program were more highly correlated with application items on the posttest than they were with knowledge items on the posttest (see Table 9). Application item scores on the posttest tended to be more highly related to errors in the program than were the knowledge item

Table 8

Correlations Between Pretest Scores and Errors During Learning and Between Review Test Scores and Errors During Learning

Booklet	N	Total pretest with errors	Knowledge items with errors	Application items with errors	Review test with errors
I	161	-.37 *	-.08	-.43*	-.36 *
II	161	-.40 *	-.23 *	-.37 *	-.37 *
III	161	-.39 *	-.16 **	-.25*	-.49 *

*Significant at .01 level.

**Significant at .05 level.

Table 9

Correlations Between Delayed Posttest Scores and Errors During Learning [a]

Book	N	Total posttest [b] with errors	Knowledge items with errors	Application items with errors
I	154	-.50	-.40	-.43
II	154	-.48	-.31	-.47
III	154	-.41	-.32	-.37

[a] All correlations significant at .01 level.

[b] Correlation between knowledge subtest scores and application subtest scores was .43.

scores on the posttest. This corresponds to the relationship found with the pretest. The correlations of posttest knowledge items with errors in Books I, II, and III were -.40, -.31, and -.32, respectively. The correlations of errors in the program with posttest application items for Books I, II, and III were -.43, -.47, and -.37, respectively (N = 154).

For the total posttest score following Books I, II, and III the correlation with the number of errors made in the program was, -.50, -.48, and -.41, respectively.

These data seem to indicate that a fair amount of the posttest score is associate with the errors made during learning, and that the knowledge and application subtests are about equivalent in their relationships to the errors made during learning.

Retention test scores. The total retention test score was correlated with the number of errors made in the three booklets; with Book I the correlation was -.32; with Book II it was -.30; and with Book III it was -.47.

The total retention test score also was correlated with the total pretest and posttest scores, .50 and .63, respectively. The retention test was more highly related to application item scores than to the knowledge item scores on both the pre and posttests, in spite of the fact that there were more knowledge items in the retention test. The correlation of the retention test with the pretest knowledge items was .07 ($p > .05$), and with the scores on the pretest application items it was .56. With the posttest, the retention test score on the knowledge items was correlated .41 and on the application items it was correlated .64.

While the total retention test correlated only .06 with the application items subtest, it correlated .92 with the knowledge subtest. On the posttest, the total score correlation with the application subtest and the knowledge subtest was .90 and .77, respectively. On the pretest, because of variance differences, it can be assumed that both subtests contributed equally.

The knowledge and application items of both the immediate and delayed posttest are supposed to measure the degree to which students know and apply necessary rules. The materials in the programed booklets contain many examples of ordinary language arguments that are application items; this is part of the instruction. As a student goes through the program,he learns a series of rules as well as a series of applications. Since the programs contain a good number of applications, immediate testing that requires Ss to apply rules would most likely yield fairly high scores; however, specific application items would be difficult to memorize (i.e., there are many semantic contexts involved). It is possible to memorize the rules and the names of propositions, etc., which means that the decreased scores on the application subtest (relative to the knowledge subtest) do not necessarily represent a change in the degree to which students are able to apply rules. The decreased application score may actually represent a retention decrement for the specific application items contained in the logic materials. In other words, application items on the immediate posttest may not be application items, in the same sense, on the delayed posttest. On the delayed posttest, application items provide a more adequate index of the students' ability to apply rules. In short, the posttest, depending upon its propinquity with the test, may not reveal generalized transfer to application items; rather, the posttest may merely indicate that the student has recently dealt with this type of item.

Correlational analyses of tests. The trends support the findings obtained by Frase (1963), who, in an earlier study using Booklet I of the same self-instructional logic program, found that scores on application items were more related than knowledge items to student performance during learning.

The correlation of the knowledge item test scores with the application item test scores was .16 ($p > .05$) on the pretest; .43 ($N = 157$, $p < .05$) on the immediate posttest; and -.25 ($p < .05$) on the retention test ($N = 57$). The last correlation is especially interesting, for it suggests that retention and transfer can be negatively correlated. This could be interpreted to mean that students who retained the material best were least able to transfer their knowledge. The retention test total score, correlated with the retention test knowledge items, was .92, but the total score correlated with the application items was only .06 ($p > .05$). This difference in the two correlations was obtained, in spite of the fact that the standard deviations of the two variables were comparable (knowledge items = 3.2, application items = 3.8). This indicates that the delayed posttest score variance was primarily due to application items.

Since the content of each book is quite different from the other books, the number of errors made on one book tended to have a low correlation with the number of errors made on other books: for Books I and II, $r = .39$; for Books II and III, $r = .55$; and for Books I and III, $r = .36$.

Relationship between pretest and posttest scores. The correlation of pre and posttest scores was .62. The pretest application items were correlated .62 with the posttest total, while the pretest knowledge items were correlated .23 with the posttest total ($N = 155$). Application items were not only predictors of the errors *Ss* made in the program, but also of the scores *Ss* made on the posttest.

The correlation of application items on the pretest with application items on the posttest was .63. The correlation of knowledge pretest scores with knowledge posttest scores was only .24. This suggests that the application items are more reliable than the knowledge items.

Experiment III

The Implications of Training in Logic for Incongruity and Atmosphere Effects

Status: COMPLETED

Purpose

In a syllogistic logic, formal words determine two specific characteristics of a categorical proposition, its quality and its quantity. The quality of a categorical proposition is either affirmative or negative; the quantity of a categorical proposition is either universal or particular. According to the atmosphere hypothesis, the quality and quantity of formal words (quantifiers) in the premises of a syllogism create an atmosphere which influences the conclusion that students will draw. The full statement of the atmosphere hypothesis is:

> "The atmosphere of the premises may be affirmative or negative, universal or particular. Whatever it is, according to the hypothesis, it creates a sense of validity for the corresponding conclusion."
> (Woodworth and Sells, 1935)

> "In general formulation the secondary hypotheses suggested for application to syllogistic reasoning are (1) that a particular premise creates a some atmosphere, even though the other premise be universal, and (2) that a negative premise creates a negative atmosphere even though other premise be affirmative."
> (Woodworth and Sells, 1935)

Woodworth and Sells (1935) deliberately chose the symbolic or abstract from (e.g., all A is B), rather than the concrete form (e.g., all mothers are bad) of syllogism, on the grounds that semantic influence would be a confounding factor in their design. The purposes of this experiment were (1) to determine whether or not the atmosphere effect holds for logically trained as well as logically naive students when trained with either linear or branching programs; (2) to determine whether or not there are negative effects from language habits to formal syllogistic reasoning; (3) to replicate results of atmosphere experiments (Woodworth and Sells, 1935; Sells, 1936); and (4) to determine the utility of using semantic differential word ratings (Osgood, Archer, and Miron, 1962) in predicting the acceptability of syllogistic conclusions which contain congruont or incongruent semantic terms.

Hypotheses

The following hypotheses were examined:

1. Gains in scores on a syllogistic reasoning test will differ following learning from a linear and/or a branching program.

2. A negative transfer effect in the learning of formal syllogistic reasoning will occur as a result of the established language habits of the students.

3. The Woodworth and Sells (1935) experiment can be replicated with the present materials.

4. The atmosphere effect does not hold as well after training as it does before training in logic has been received.

5. The atmosphere effect embraces concrete forms where congruent or incongruent semantic terms are used in the syllogistic conclusion.

Method

Subjects

Ss for this experiment were four classes of introductory logic students at Colorado State University (N = 109).[3]

Procedure

The independent variables investigated in relation to learning and transfer included the presentation form of the logic program (linear and branching) and the form of the items on the syllogistic reasoning test (congruent and incongruent). The three program forms were identical to those used in Experiment II.

Syllogistic test items, representing both abstract and concrete aspects of the same syllogistic forms, were included in the present design in order to examine the problems of language that are related to atmosphere predictions. The concrete items were constructed to maximize, or minimize semantic congruity or incongruity. As a means of operationally defining congruity and incongruity, the evaluative scores of nouns were secured from English speaking students through the use of the semantic differential (Osgood, Archer, and Miron, 1962). For instance, an incongruous conclusion, "All mothers are bad", is composed of a positive assertion, "All ... are", between a noun (mother) related very high on the evaluative scale and an adjective (bad) rated very low on the evaluation scale. Correspondingly, the conclusion, "All mothers are good", would be considered congruent (see Osgood, Suci, and Tannenbaum, 1956, concerning the principle of congruity).

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[3] Provided by the course instructor, Dr. Donald Roberts, who cooperated in and collected the data for this experiment.

For any particular mood of a syllogism there are alternative conclusions which are either congruent or incongruent, and which are either predicted or not predicted by the atmosphere hypothesis. In the case of the abstract items, there presumably would be no semantic context operating; consequently, they provide a baseline for comparison. In short, there were 48 five-choice syllogisms matched as to mood and figure: 16 in abstract form, 16 in which the conclusion predicted by the atmosphere hypothesis was semantically congruent, and 16 in which the conclusion predicted by the atmosphere hypothesis was semantically incongruous (see Appendix A for items data). The syllogistic test was given to students before and after logic training under the three program conditions.

Results

Comparison of Linear and Branching Programs

There were no differences between the maximum linear, minimum linear, and branching programs on any of the dependent variables, including the syllogism test.

The interrelationship of performance measures under the three program conditions remains essentially the same as in Experiment II. In this experiment there was no analysis of application and knowledge items, nor was a review test included.

Atmosphere and Congruity Hypotheses

Figure 1 summarizes the results of the present experiment and indicates the absolute and relative number of choices for the various alternatives.

Atmosphere choices. Figure 1 shows that the absolute number of choices successfully predicted by the atmosphere hypothesis (about 8) exceeds the absolute number of choices successfully predicted by the congruity hypothesis (about 3), although the probability of each choice is only .2 in the former case and .4 in the latter. The probability of the number of choices being as great as it was for both correct choices and choices predicted by semantic congruity is at the chance level,while the same probability for the atmosphere hypothesis is beyond the .02 level. Figure 1 shows that choices of congruent alternatives were more numerous than choices of incongruent alternatives, but that both were more numerous than choices of matched abstract alternatives. In confirmation of the hypothesis offered by Woodworth and Sells (1935), it can be said that it is possible to predict that students will tend to judge certain conclusions to be valid when, in fact, they are invalid.

The present experiment provides a somewhat modified test of the atmosphere hypothesis since Ss may actually choose between several alternative conclusions. In Sells' (1936) experiment, Ss were required to choose between "absolutely true", "probably true", "absolutely false" and "does not follow".

Table 10 summarizes the results of the analysis of variance on the number of atmosphere choices. The results clearly show that the atmosphere effect was sharply reduced after the experience with the logic materials. Since

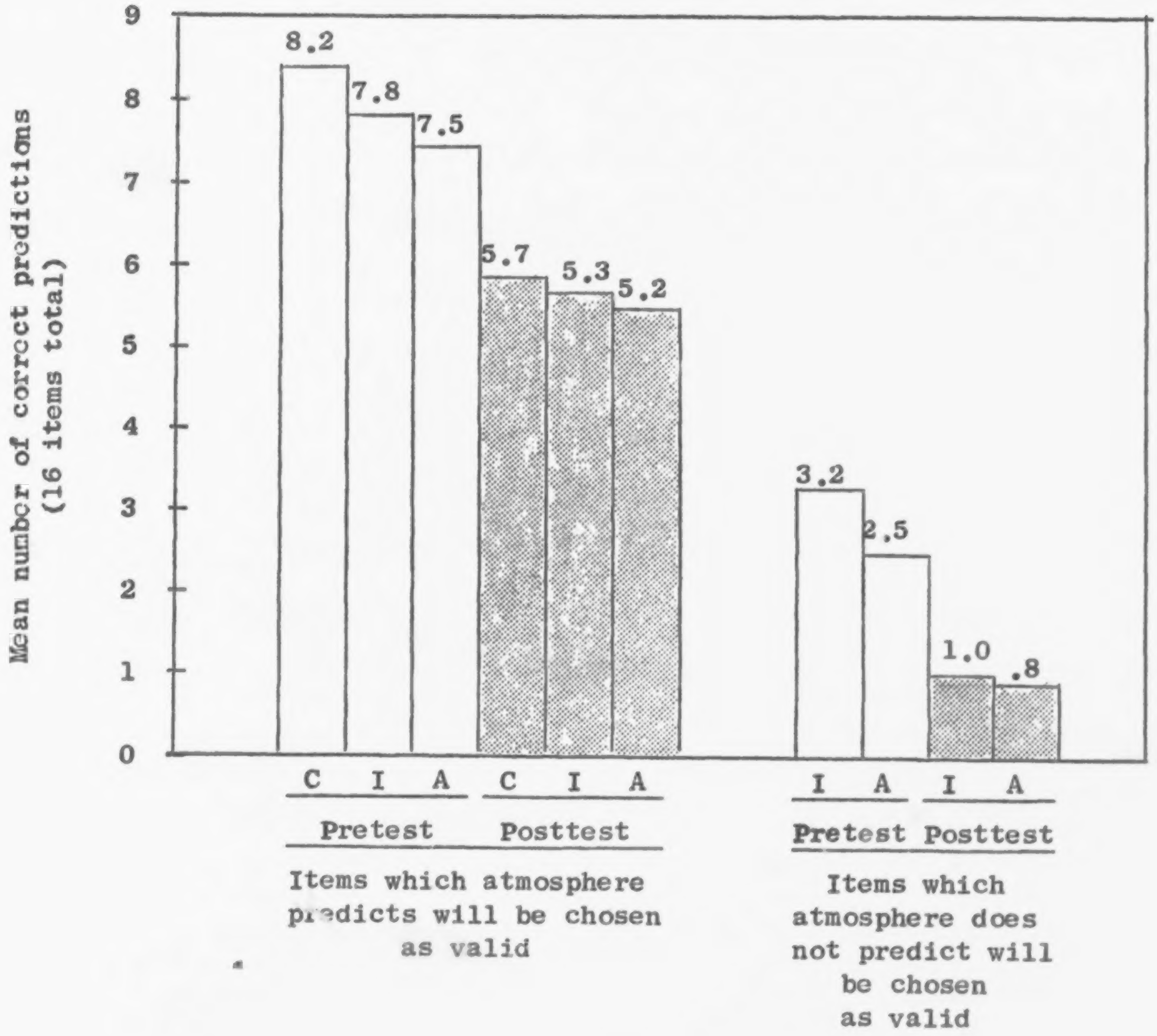

Fig. 1. Summary for Experiment 3 of Predictions Correctly Made on the Basis of Atmosphere for Concrete-Congruent Items (C), Concrete-Incongruent Items (I), and Abstract Items (A) on Pre- and Posttests.

Table 10

Analysis of Variance on the Number of Atmosphere Choices on Pre and Posttest for Congruent, Incongruent, and Abstract Test Items

Source	MS	df	F	P
Pre-Post Tests (P)	551.63	1	48.05	<.001
Concrete-Abstract (C)	12.42	2	5.72	<.01
Subjects (S)	16.30	61		
Interactions:				
P x C	.74	2	7.65	<.001
P x S	11.48	61	1.45	<.05
C x S	2.17	122		
C x S x P	1.50	122		

Ss were not given feedback about their responses on the pretest, improvement on the posttest (by virtue of pretest experience) should have been minimized.

Both of the main effects of the analysis of variance are significant. It is interesting to note that more atmosphere choices (all but two of these were incorrect) were made for the concrete items, and that the order of congruent and incongruent items is in the predicted direction; namely, people are likely to accept an invalid conclusion if the conclusion makes a positive statement about something they consider good, or if it makes a negative statement about something they consider bad.

Aside from the statistical indication that some people tend to perform better on one test condition than on another, there is an indication that Ss respond differently to the concrete and abstract items (significant interaction, $p < .05$).

The number of erroneous judgments that reveal the difference of the atmosphere effect is at the chance level on the posttest. A difference in the atmosphere effect between concrete and abstract items was found.

Congruent choices. In absolute numbers, the choices successfully predicted by the congruity hypothesis (when opposed to the atmosphere predictions) is quite low. Two choices on each item are predicted by the congruity hypothesis, and hence, the probability of a correct prediction is .4 for each item; yet,the average number of correct predictions is less than three on the pretest, and less than one on the posttest. The low number of predictions indicates that the semantic context of the conclusions may not be a powerful factor in determining Ss responses relative to the atmosphere effect. The items from which this information was drawn, however, only include those in which a congruent choice would mean a choice contrary to the atmosphere hypothesis.

Table 11 summarizes the analysis of variance relating the number of predictions correctly made by the congruity hypothesis. Once again, there is a large difference in pre and posttest performance -- a decrease in the number of congruous choices. Interaction effects between the concrete-abstract levels and Ss are not statistically significant. Interaction between pre-posttest and Ss indicates individual differences in the effects of congruity before and after training in logic.

An interesting point to note is that,on the posttest,the absolute number of choices predicted by semantic congruity was below chance ($p < .006$), while the number of choices predicted by the atmosphere hypothesis was at a chance level. Both factors seemed to decrease in importance at about the same rate (slopes of lines). The number of correct choices is well beyond the chance level on the posttest, but the fact that 32 per cent of the items were incorrect indicates the difficulty level of the test.

Correct choices. Figure 2 summarizes the substantial difference in the number of correct choices for the concrete and the abstract items. In confirmation of the Woodworth and Sells (1935) and Wilkins (1928) data, more correct choices are made with concrete items.

Table 12 summarizes the analysis of variance for the number of correct choices. The advantage of concrete over abstract items is beyond the .001 level, as is the difference between pre and posttests. The lack of interactions seems

Table 11

Analysis of Variance on the Number of Congruent Choices on Pre and Posttests for Concrete and Abstract Test Items

Source	MS	df	F	P
Pre-Post Test (P)	222.68	1	51.42	<.001
Concrete-Abstract (C)	12.20	1	6.52	<.02
Subjects (S)	5.41	61		
Interactions:				
P x C	4.94	1		
P x S	4.33	61	2.69	<.001
C x S	1.87	61		
C x S x P	1.61	61		

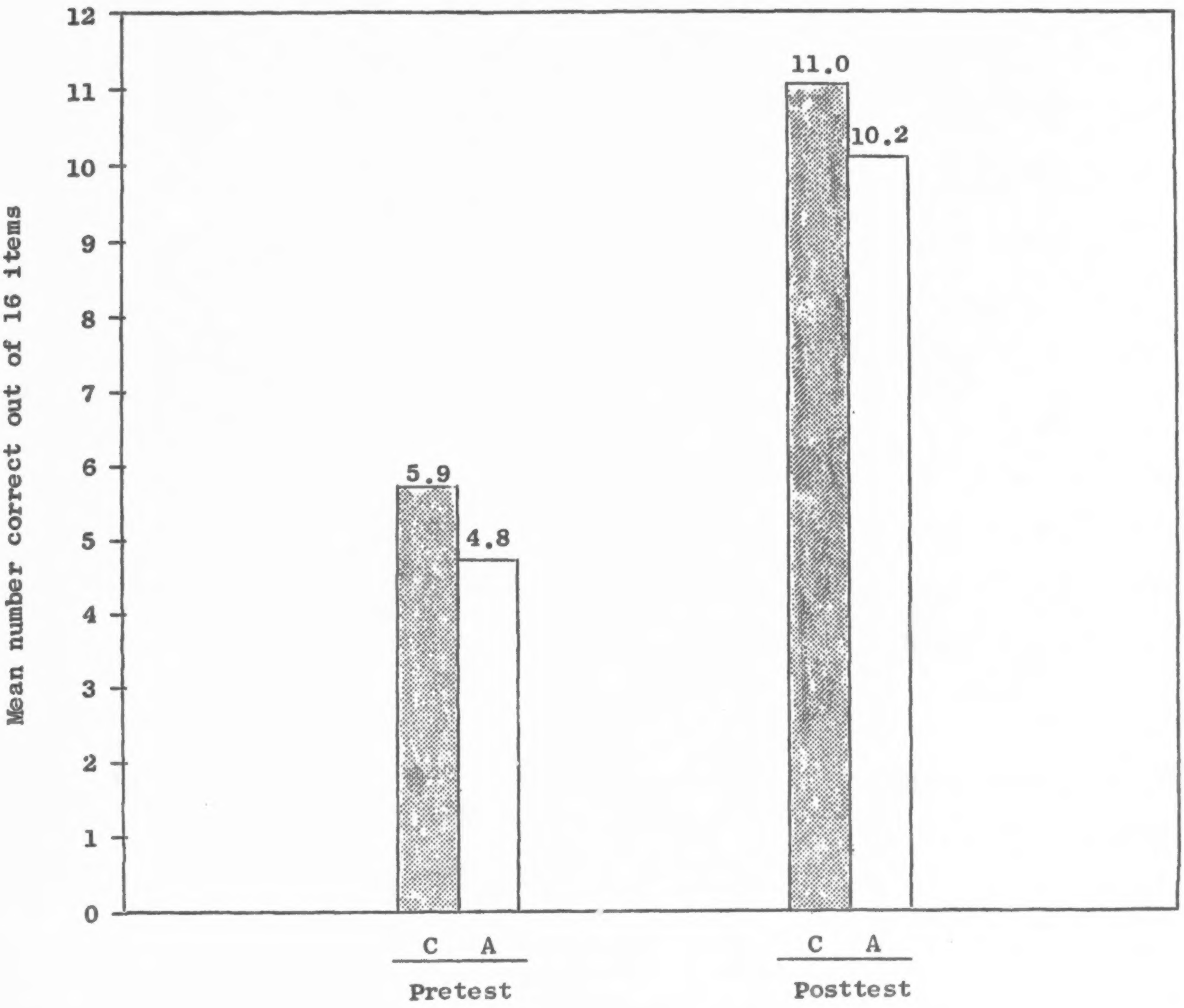

Fig. 2. Summary of Mean Number of Correct Choices Made for Concrete Items (C) as Opposed to Abstract Items (A) in Pre- and Posttests.

Table 12

Analysis of Variance on the Number of Correct Choices on Pre and Posttests for Abstract and Concrete Test Items

Source	MS	df	F	P
Pre-Post Tests (P)	1698.39	1	98.57	<.001
Concrete-Abstract (C)	59.04	1	42.78	<.001
Subjects (S)	31.81	61		
Interactions:				
P x C	10.70	1		
P x S	17.23	61		
C x S	1.38	61		
P x C x S	93.42	61		

to indicate that there were few differential effects of concrete and abstract items, although there were such effects for atmosphere choices. Although there were no differential effects of test levels for correct choices, there were such effects for congruent choices and atmosphere choices. Since most of the correct choices were "none of the above", people who tended to be affected by semantic and atmosphere effects should have shown the greatest amount of improvement with experience in logic, hence, there is an interaction of Ss with test conditions under the two analyses in which the determining factors were non-logical. From these analyses one might say that people arrive at correct responses in the same manner, but their choice of incorrect responses reflects their particular dispositions.

Intercorrelations

The correlation of the syllogism test with errors in the program and scores on the logic pre and posttests is of interest because it relates directly to the theoretical orientation of previous research on the development of learning sets (conceived as developing abilities) by Bass, Hatton, McHale, Stolurow (1962).

Tables 13 and 14 present correlations of the total pretest and total posttest with the parts of those tests. It can be seen that, in all cases, the concrete items correlate higher than the abstract items with total scores and that the relative differences, especially concerning atmosphere choices, are reduced under the posttest condition. In addition, the incongruent items correlate higher than congruent items with total scores on the pre and posttests. This suggests the importance of verbal fluency in reasoning, confirming the findings of Sells (1936) in that respect.

Table 13

Correlation of Items on the Syllogism Tests With the Total Pretest Score N=62

Test	Correlation with total pretest scores						
	Congruent choices		Atmosphere choices			Correct choices	
	Concrete	Abstract	Incongruent	Congruent	Abstract	Concrete	Abstract
Pre	-.52	-.18	-.48	-.33	.01	.91	.76
Post	-.31	-.12	-.22	-.16	-.11	.31	.30

Note: -- There were 16 test items for each of the subtests above.

Table 14

Correlation of Items on the Syllogism Tests With the Total Posttest Score N=62

Test	Correlation with total posttest scores						
	Congruent choices		Atmosphere choices			Correct choices	
	Concrete	Abstract	Incongruent	Congruent	Abstract	Concrete	Abstract
Pre	-.15	-.03	-.17	-.07	.05	.33	.31
Post	-.70	-.34	-.78	-.74	-.61	.94	.93

Note: -- There were 16 test items for each of the subtests above.

Summary

1. There were no differences that could be related to linear or branching programs on any dependent variables.

2. The atmosphere effect does not hold equally before and after training. Training reduces the influence of the atmosphere on reasoning.

3. The Woodworth and Sells (1935) results can be obtained with a five-alternative, multiple-choice format. A significant number of correct predictions of student choices can be made from the atmosphere hypothesis; however, even more correct predictions can be made with concrete, semantically congruous items, or with semantically incongruous items than with abstract items such as Woodworth and Sells used.

4. Using concrete items, the Woodworth and Sells' findings were extended and modified. People accept an invalid conclusion that makes a positive statement about something they consider good, or a negative statement about something they consider bad. This can be interpreted as an additional form of atmosphere effect.

Experiment IV

The Separate and Joint Effects of Congruity and Atmosphere

Status: Completed.

Purpose

The purpose of this experiment is to determine whether or not there is a statistical interaction between two semantic effects -- congruity and atmosphere. This is essentially a replication of Experiment III, except that this experiment includes items which are congruent but which the atmosphere hypothesis does not predict will be called valid.

Method

Subjects

Forty-four students from an introductory logic course at the University of Illinois served as Ss for this experiment.[4]

Procedure

A test was constructed in which there were 56 syllogisms. The S was required to indicate whether each syllogism was valid or invalid. The syllogism test can be divided into four parts: (1) those which both the atmosphere and the congruity hypotheses predict will be called valid, (2) those which only the atmosphere hypothesis predict will be called valid, (3) those which only the congruity hypothesis predicts will be called valid, and (4) those which neither hypothesis predicts will be called valid. This defines a two x two x

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[4] Provided by the course instructor, Mr. S. Jack Odell, who assisted in the conduct of this experiment.

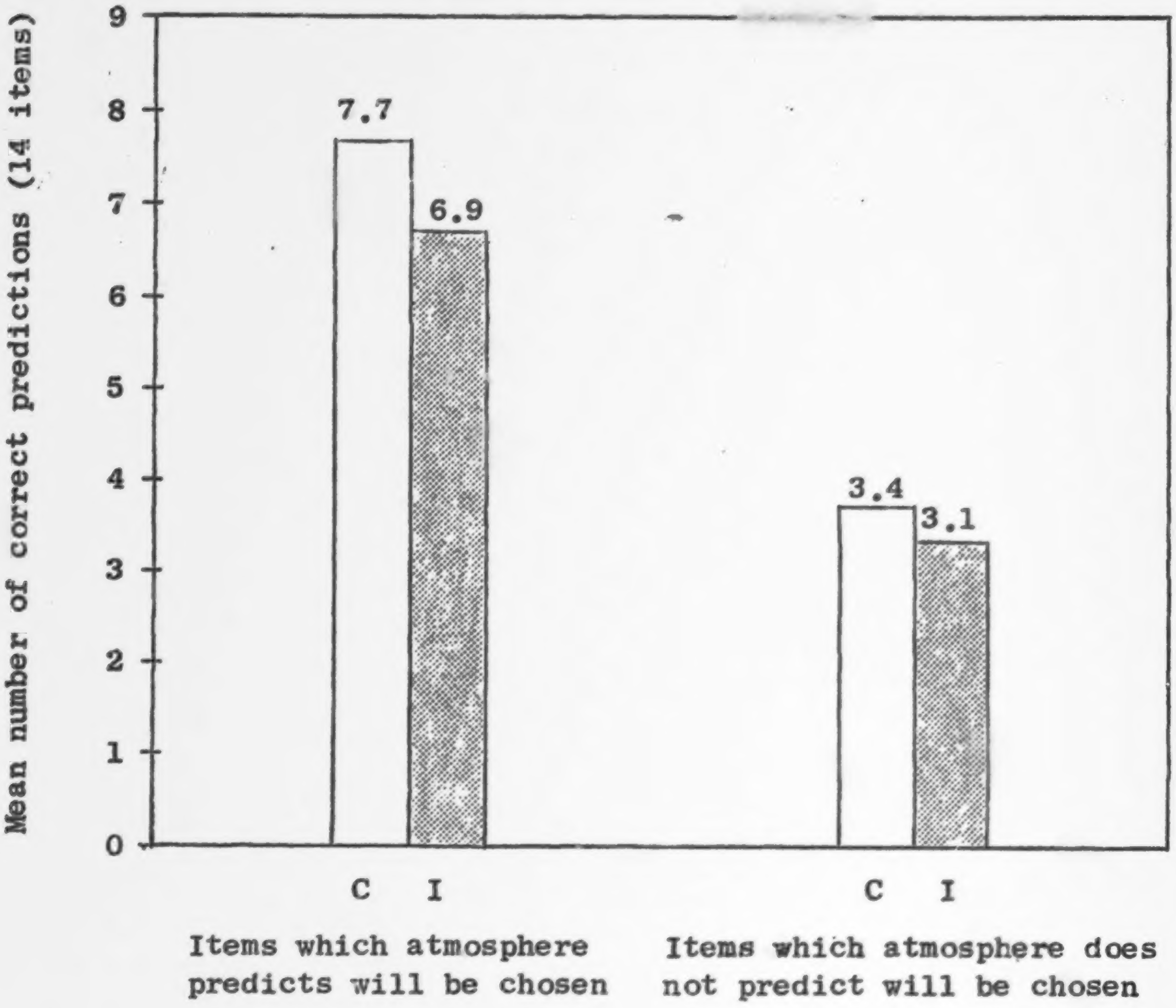

Fig. 3. Summary of Predictions Correctly Made on the Basis of Atmosphere and Congruity (C = Congruent; I = Incongruent).

Note. -- All of these items were invalid, but subjects called them valid.

Table 15

Analysis of Variance on Incorrect Choices

Source	MS	df	F	P
Atmosphere	740.5	1	184.3	<.001
Congruity	11.5	1	7.5	<.01
Subjects	10.6	43		
Interactions:				
A x C	3.0	1	1.6	
A x S	4.0	43	2.1	<.01
C x S	1.5	43		
A x C x S	1.9	43		

Ss design for the experiment in which the interaction of the two factors can be clearly revealed. See Appendix B for the item characteristics of the syllogism test.

Results

Ss have not yet finished the logic materials so that no posttest scores were available. Figure 3 summarizes the relative and absolute number of incorrect choices for the alternative items.

Table 15 presents the analysis of variance on incorrect choices for the four forms of items. From Table 15 it can be seen that the results of this experiment replicate those of Experiment III with regard to the relative effect of congruity and atmosphere and the relative effect of congruous and incongruous terms included in syllogistic conclusions. With the two-choice alternative (valid or invalid), the selection of conclusions on the basis of atmosphere for concrete items is at the chance level, suggesting the elimination of the atmosphere effect. In addition, Ss exhibited different responses when given atmosphere items, which is consistent with data obtained by Sells (1936). Responses to congruity differences did not differ across students. There was no statistical interaction between congruity and atmosphere effects.

Experiment V

Relative Transfer Effects of Learning Systems of Notation for Encoding Expressions in a Course of Programed Symbolic Logic

Status: Data has been collected and materials are being revised.

Purpose

The relative merits of teaching alternative notational systems in logic, especially the Peano-Russell (P) and Polish (St. Lesniewski and Lukasiewicz) systems (L), are, unfortunately, unknown. There is no empirical evidence bearing on their relative effectiveness for learning or their use by different individuals. The English speaking student who is required to learn the Polish notation must overcome competing language habits in order to learn the meaning of 'CKApqNpq', for example, since the operators refer to symbols in a sequence quite unlike the English language. The habitual eye-movements are conflicting and this difficulty is compounded by the introduction of a new conceptual system. However, some of the ambiguities of parenthetical notation presented in the Peano-Russell system may be eliminated by the Polish notation. With the Peano-Russell notation, on the other hand, the student who must learn the meaning of '$[(p \vee q) \cdot \sim p] \supset q$' might find the task easier than the alternative Polish expression for two reasons: first, the similarity of the new system to algebraic notation (especially if he were high in mathematical ability) and, second, the similarity between the eye-movements required by the new system and his native language.

In terms of transfer of training, the American student learning to write in one of these notational systems will be learning new responses to old stimuli (sentences and words), and these responses will either be similar to previously learned responses (Peano-Russell notation) or dissimilar (Polish notation). The latter case, learning dissimilar responses to old stimuli, is typically optimal for negative transfer. The first question to be answered is whether or not one notational system is more difficult to learn initially.

A further question concerning transfer is whether or not learning one system first makes it easier to learn the other system. Further, does learning one system lead to greater transfer than learning the other system when the criterion of transfer is performance on materials that are different from those used in the learning task?

Other questions concerning the relationships of the learner's mathematical, verbal, and general reasoning abilities to performance in the two notational systems arise which have import for adaptive, individualized, computer-assisted instruction, e.g., would it be more efficient to assign students with high mathematical ability to one or the other of these notational systems initially? Does high verbal ability or does high general intelligence indicate which treatment would be the optimum assignment?

Hypotheses

1. Learning scores for two groups, one learning the Polish notation and the other learning Peano-Russell notation, will differ. It should be easier to learn the Peano-Russell notation.

2. When groups, that originally learned one notational system, must learn the other notational system, transfer scores for the two groups will differ.

3. A group of ability tests administered to Ss will be significantly related to performance on the logic programs.

Method

Subjects

Sixty students in an introductory logic course at the University of Illinois, and 60 students in an introductory logic course at the University of Buffalo, New York, will serve as Ss.

Materials

Pretests. A pretest covering the material contained in the programed text will be given to all students. In addition, ability tests (adapted from the Educational Testing Service, Cognitive Reference Battery, compiled by John French, et. al., 1963) covering vocabulary (V-4), inference (Rs-3), mathematical aptitude (R-2), and inductive reasoning (I-1) will be given. The latter test is particularly applicable to system L (Polish), since it requires the student to make inferences from combinations of letters. In addition to these tests, college entrance examination scores will be available.

The 16 PF, Form A, (developed by W. Cattell at the Institute for Personality and Ability Testing, Champaign, Illinois) personality test will be administered to all subjects. This test provides information on 16 personality factors, including general intelligence, emotionality, and tension.

Logic program. Five books of programed logic covering topics from language to propositional logic in both the Polish and Peano-Russell systems were developed at the Training Research Laboratory.[5] Both sets of five books were designed to parallel each other.

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[5] John Kearns, Ph.D., S. Jack Odell, M.A., and James Zartman, Ph.D. wrote the initial version of this program.

Posttests. After the Ss complete each logic book, they will be given an immediate posttest over the material covered in that book. In addition, an overall test will be given which parallels the logic pretest. This test will be given after all logic books have been completed. A transfer test, requiring the S to apply his knowledge of logic to new areas (such as electrical circuits) will be given after the logic posttest.

Procedure

Since it would be difficult for an instructor to teach both notational systems to different classes during one semester, the New York group will study system L for an entire semester. Their final examination required them to use the Polish as well as the Peano-Russell notation. The Illinois group studied P all semester and took the same final examination as the New York group which required each of them to transfer to the other notation.

The experiment is designed to yield two types of data: (1) instructional data -- characteristics of the logic materials, errors made on each item of the program, time spent on individual frames, test scores, and students' comments on the material; and (2) experimental data--characteristics of transfer of training. Instructional and experimental data will be used both for the elaboration of materials and for the correction of errors and inadequacies in the materials. The experimental design and data to be obtained are summarized in Table 16.

Correlational methods will be used to relate personality and aptitude to performance on the logic program and tests. The difference in performance on learning and transfer tasks (and their associated tests) can provide a measure of transfer. Covariance may be used for comparisons of learning scores and of transfer scores.

Results

Data being analyzed.

Table 16

Experimental Design of Transfer From Notational System L to System P, and From Notational System P to System L

Measures	Group 1	Group II
Pretest[a]	Given	Given
Learning task	Books 1-5 P	Books 1-5 L
Posttest[b]	Given	Given
Transfer task[c]	Books 1-5 L	Books 1-5 P
Posttest	L and P	P and L

[a] Personality, aptitude and logic tests.

[b] Posttests were administered after each book. A general logic posttest and a transfer test were administered to Ss after they had completed their first program.

[c] Performance judged in terms of study time and errors.

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Appendix A

Item Characteristics of the Syllogism Test Used in Experiment III

Concrete Items in Which Atmosphere Choice is Incongruent

Item number	Mood[a]	Alternative				
		a	b	c	d	e
2	OE	c	-c	c	$\underline{-c}$	x
9	EI	c	-c	c	$\underline{-c}$	x
18	OE	c	-c	c	$\underline{-c}$	x
20	IO	c	-c	c	$\underline{-c}$	x
28	AO	c	-c	c	$\underline{-c}$	x
31	OA	c	-c	c	$\underline{-c}$	x
35	IE	c	-c	c	$\underline{-c}$	x
38	OA	c	-c	c	$\underline{-c}$	x
39	IO	c	-c	c	$\underline{-c}$	x
40	IE	c	-c	c	$\underline{-c}$	x
42	EO	c	-c	c	$\underline{-c}$	x
43	EI	c	-c	c	$\underline{-cx}$	
44	AE	c	$\underline{-c}$	c	-c	x
45	AE	c	$\underline{-c}$	c	-c	x
49	AA	$\underline{-cx}$	c	-c	c	
54	EO	c	-c	c	-c	x

Concrete Items in Which Atmosphere Choice is Congruent

Item number	Mood[a]	Alternative				
		a	b	c	d	e
48	OE	-c	c	-c	$\underline{c}$	x
1	EI	-c	c	-c	$\underline{c}$	x
15	OE	-c	c	-c	$\underline{c}$	x
12	IO	-c	c	-c	$\underline{c}$	x
24	AO	-c	c	-c	$\underline{c}$	x
22	OA	-c	c	-c	$\underline{c}$	x
12	IE	-c	c	-c	$\underline{c}$	x
10	OA	-c	c	-c	$\underline{c}$	x
17	IO	-c	c	-c	$\underline{c}$	x
52	IE	-c	c	-c	$\underline{c}$	x
27	EO	-c	c	-c	$\underline{c}$	x
14	EI	-c	c	-c	$\underline{cx}$	
5	AE	-c	$\underline{c}$	-c	c	x
37	AE	-c	$\underline{c}$	-c	c	x
8	AA	$\underline{cx}$	-c	c	-c	
23	EO	-c	c	-c	$\underline{c}$	x

Note: -- c=congruent conclusion; -c=incongruent conclusion; x=correct conclusion; underlined letters indicate atmosphere prediction.

[a] A=All X are Y; E=No X are Y; I=Some X are Y; O=Some X are not Y.

Abstract Items

Item number	Mood[a]	Alternative				
		a	b	c	d	e
36	OE				_	x
16	EI				_	x
29	OE				_	x
7	IO				_	x
19	AO				_	x
4	OA				_	x
11	IE				_	x
41	OA				_	x
46	IO				_	x
50	IE				_	x
13	EO				_	x
25	EI				$\underline{x}$	
30	AE		_			x
33	AE		_			x
26	AA	$\underline{x}$				
53	EO				_	x

Note: -- x=correct conclusion; _=atmosphere prediction.

[a] A=All X are Y; E=No X are Y; I=Some X are Y; O=Some X are not Y.

Appendix B

Item Characteristics of the Syllogism Test Used in Experiment IV

The following groups of items are divided as follows:

Group I. Both atmosphere and congruity hypothesis predict that the syllogism will be called valid.

Group II. Only the atmosphere hypothesis predicts the item will be called valid.

Group III. Only the congruity hypothesis predicts the item will be called valid.

Group IV. Neither hypothesis predicts a choice of valid.

The item number is given first, then the mood[a] of the syllogism (all in Fig. 1).

Group I	Group II	Group III	Group IV
3. IEO	9. AEE	2. OAI	1. IEE
5. OEO	12. EOO	4. EOA	6. IOA
7. EOO	14. IEO	11. AEA	8. AOI
10. IOO	15. OEO	13. IOA	16. AEI
19. IEO	25. IOO	17. IOI	18. EOA
21. EOO	26. IOO	20. IEE	23. AEA
22. AEI	29. AEE	24. OEO	27. IEI
31. AEE	33. OAO	28. OEA	34. EOE
35. AOO	44. EOO	30. IEI	36. OEE
37. AEE	45. AOO	32. OAE	38. AEO
39. OAO	49. OEO	41. EOE	40. OAI
42. OAO	53. AEE	47. OEE	46. IOI
43. AEE	55. IEO	52. AOI	48. OAE
50. IOO	56. OAO	54. AEA	51. OEA

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[a] A=All X are Y; E=No X are Y; I=Some X are Y; O=Some X are not Y.

Chapter IV

The Use of a Model and a Generalized Preview to Facilitate the Learning and Retaining of Complex Scientific Materials[1]

M. David Merrill

Status: COMPLETED -- M. David Merrill. Learning and Retention Effects of a Model and a Preview in Teaching an Imaginary Science, Technical Report No. 3, November, 1963.

Experiment I

Purpose

Several competing principles concerning the organization of materials to promote learning and transfer exist in education and educational psychology. Programed instruction provides a useful medium for the examination of these principles since they can be used to prepare sequences of frames for comparative study. The effects of each can be readily determined in terms of performance differences of students. This study compares some competing notions about the way to organize complex materials. One program meets the organizational requirements of Ausubel's subsumption theory (1963) and three other logical alternatives were used.

Hypotheses

Based on Ausubel's subsumption theory and its implications for the use of "advance organizers," it was hypothesized that presenting a model and/or a preview prior to the presentation of complex verbal materials would facilitate the learning and retention of those materials.[2]

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[1] This study was done in partial fulfillment of the requirements for a Master of Science degree in education. A related study was completed as a doctoral dissertation: Merrill, M. D. Transfer effects within a hierarchical learning task as a function of review and correction on successive parts. Urbana, Ill.: Univer. of Ill., Trng. Res. Lab. Nonr Contr. 3985(04), Tech. Rept. #5, Sept. 1964.

[2] Experimental program is on file in the Univer. of Ill. library the title "Xenograde Systems: An Experimental Program" by M. D. Merrill (unpublished).

Method

Subjects

Four groups of high school students were divided into high and low IQ groups.

Procedure

Group 1 was presented a model and a preview prior to learning a complex imaginary science; Group 2 was presented the model prior to the science and received a review in place of a preview; Group 3 was presented a preview prior to the science; and Group 4 was presented only a review but no model or preview. The same mode of presentation was used for all groups -- linear programed booklets. Students were tested both immediately after completing the program and two weeks later.

Experiment II

Method

Subjects

Two groups of college students learned the materials that were learned by Groups 1 and 4 in Experiment I.

Procedure

The mode of instruction was by MIN-MAX teaching machine. The Ss were tested immediately following learning.

Results

Results indicated no significant main effects. There were two significant interaction effects: (1) retention as measured by application items was best for high IQ Ss when presented a model, but best for less gifted Ss when no model was presented; and (2) retention as measured by items measuring taught knowledge was best when no model or preview was presented and poorest when only a model, but no preview, was presented. [redacted]

Implications

An analysis of test performance seems to indicate that the teaching machine program was effective in teaching knowledge of terminology and knowledge of specific facts, but was ineffective in teaching understanding necessary for problem solving. Before failing to reject the null hypothesis, it would be desirable to replicate the experiment with a revised program that would enable students to attain a higher level of understanding as measured by problem solving ability.

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Chapter V

A Study of Transfer Effects in Verbal Learning

L. M. Stolurow and G. E. Brehman

Experiment I

Status: COMPLETED

Purpose

This is a study of transfer under a specific set of conditions: namely, when bi-directional associations exist between the individual words occupying corresponding positions in two serial lists learned in succession. The problem is to determine the effects of the associative relationship between the corresponding words in the two lists in terms of (1) the rate of learning of the second list (proaction), and (2) the recall of both lists following their mastery (retroaction). The study relates to mediational interpretations of transfer by revealing the potential duality of effect that can occur if the terms in two lists are both cues and responses not only within lists but also between lists.

Hypotheses

The hypotheses tested was that well established bi-directional associates will produce inhibition rather than facilitation of mastery of the second list.

Method

Subjects

Volunteers from student-teacher sections of Educational Psychology 211 were randomly assigned to the three conditions.

Procedure

Three conditions were presented (See Table 1). All three groups learned the same list of words as their second, or "B" list, the transfer task. The first, or E-1, condition consisted of an "A" list whose words were positionally opposite the bi-directional associates of the words in the standard "B" list. The second, or E-2, consisted of an "A" list whose words were bi-directional associates of the words in the standard "B" list, but not in the corresponding position. The third, or control, condition consisted of an "A" list whose words were associationally neutral with regard to the standard "B" list, but equal in difficulty and average syllable length with regard to the "A" lists of conditions E-1 and E-2. Equation as to analysis was achieved by use of data of trigram frequency reported by Stolurow, Jacobs and Blomme (1961).

Results

Data indicated that, in contrast to earlier findings in an unpublished study using uni-directional associates by Stolurow and Swenson (1949), negative transfer does, in fact, occur. In addition, accuracy of recall was found to be less when the associates were not opposite from one another, but not significantly affected when the associates were placed opposite to one another. Table 2 presents the means, standard deviations, and significance tests for the three groups.

Table 1

Experimental Design and Conditions for Learning and Transfer

Experimental Groups				Control Group	
E-1		E-2			
List A	List B	List A	List B	List A	List B
A set of 10 stimulus words from free association list placed in a sequence for learning.	The 10 response words which were the free association list matched as to position with list A.	The 10 stimulus words from list A (E-1) but in a random order.	Same 10 response words and in same order as in E-1.	10 words equated with list A in experimental groups as to difficulty and syllable length.	Same 10 response words in same order as in E-1.

Table 2

Means, Standard Deviations, and Significance Tests for All Groups

Measure	Means			F	H[a]	Standard Deviations			
	E-1 (N=20)	E-2 (N=10)	Control (N=16)			E-1 (N=20)	E-2 (N=10)	Control (N=16)	
List A trials to criterion	13.65	12.60	17.94	2.87	-	5.41	6.65	7.22	1.42
List B trials to criterion	9.65	10.60	7.84	-	10.81*	4.89	3.27	5.66	8.32**
List A accuracy of recall	9.05	5.90	8.56	5.75*	-	2.16	4.35	2.06	3.85
List B accuracy of recall .	9.85	9.80	9.87	-	-	0.37	0.63	0.35	-
Errors-actual and potential	2.45	5.00	2.00	3.59**	-	2.58	4.03	2.48	3.56
Inter-list association errors	0.50	0.00	0.00	-	9.20**	0.76	0.00	0.00	-
Intra-list association errors	1.20	2.90	1.12	5.98*	-	1.38	1.79	1.15	2.21

[a] Kreskal-Wallace H (see Siegel, 1956)

*Significant at the .01 level.
**Significant at the .05 level.

Experiment II

Status: In progress.

Purpose

The purpose of this experiment was (1) to investigate the effect of uni- and bi-directional associations between transfer lists and under improved control conditions, and (2) to investigate the question of whether the observed transfer effects are a function of the *Ss* awareness of the relationship between the two lists.

Hypotheses

1. The bi-directional association condition between words in two lists (A and B), learned one after the other, will *facilitate* the learning of the second (B) list when the words it contains are in positions that correspond to their associates in the list learned first (A).

2. The bi-directional association condition between words in two lists (A and B), learned one after the other, will *interfere* with the learning of the second (B) list when the words it contains are not in positions that correspond to their associates in the list learned first (A).

3. The uni-directional association condition will produce *facilitation* rather than inhibition when the words in the second list are in a sequence that corresponds to their associates in the first list.

4. The knowledge that there is an association between the corresponding words of the two lists will not facilitate the learning of the second list.

Method

Subjects

Ninety-six volunteers from psychology classes were randomly assigned to one of the 32 sub-groups required by the experimental design.

Procedure

Initial and transfer lists "A" and "B" (each 15 words) will be presented by visual projection for one and three fourths seconds as in Experiment I. Each S must learn four lists, two sets of "A" and "B", with each set different in content and representing one of the six basic conditions. The sets are counterbalanced as to order of presentation in order to control for position effects. Two sets of 15 word-pairs for each type of association condition, and equated as to the difficulty of the "A" lists of each set, will be used. The second, or "B" lists, of each set will remain constant in content throughout all experimental conditions, but the "A" lists will vary in the two control conditions. In the first control condition, the "A" lists will simply be interchanged so that the words in the initial "A" list no longer have the corresponding words in the "B" list as their associated response. The second control condition involves the use of completely new "A" lists that are equal in difficulty to the two previously equated "A" lists but which have no highly probable word associates connected with them, i.e., the same control condition as in Experiment I. Half of the Ss will be told. Whether or not they discover, or fail to discover, that such a relationship exists will be determined. Errors during mastery and recall, and trials to criterion during mastery will be recorded for analysis.

Results

Materials have been prepared.

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